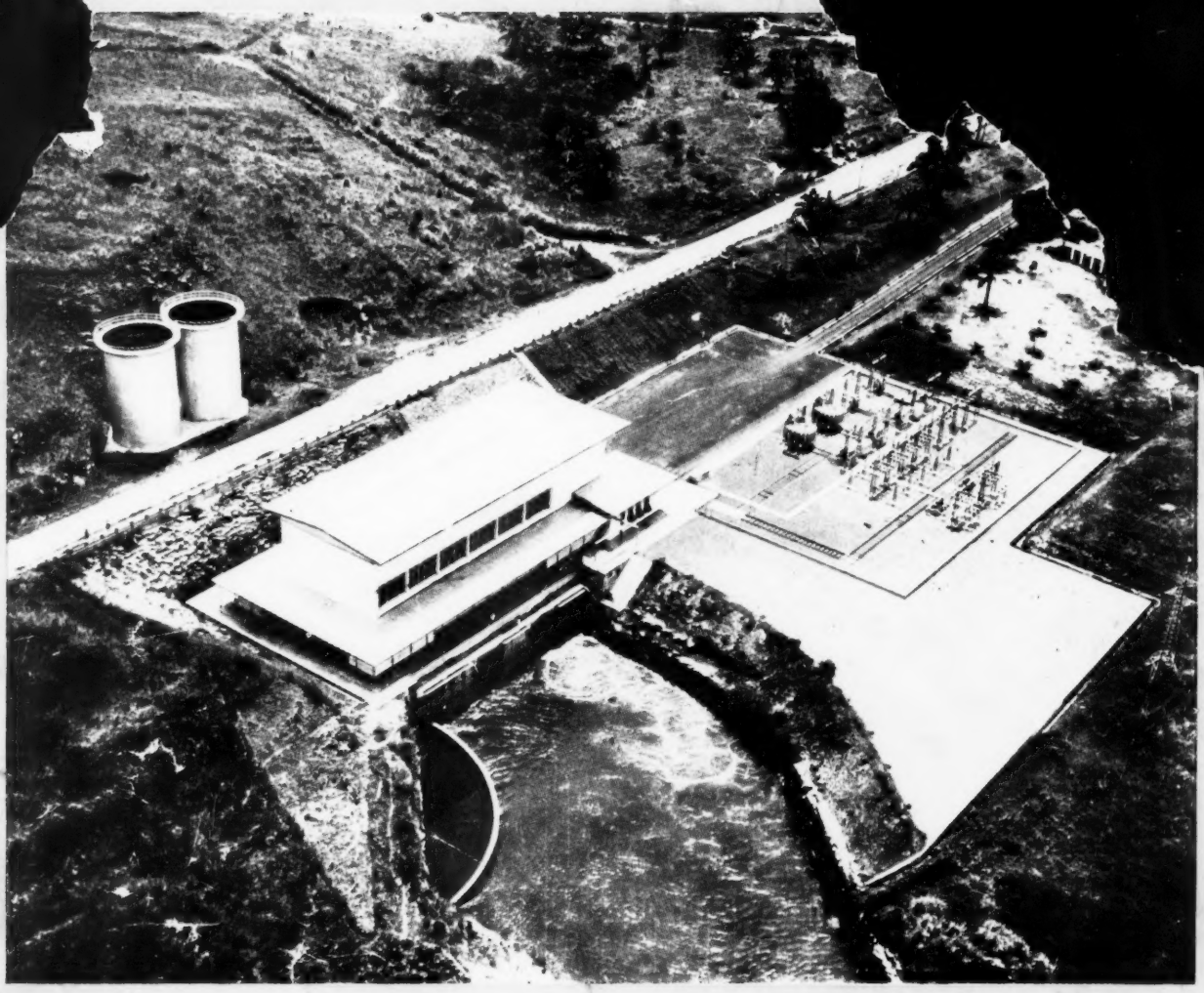
T2
163

INDIAN JOURNA
POWER & RIVER VALLEY D

X NO. 3 MARCH, 1960



DJOUE RIVER HYDRO-ELECTRIC PLANT, FRENCH AFRICA

...at scenes of progress

...RVES ...INDIA'S VITAL PROJECTS

BHAKRA DAM PROJECT :
120 RB Ward Leonard Electric,
54 RB/54 B, 38 B Diesel shovels Etc.

RIHAND DAM PROJECT :
54 RB Ward Leonard Electric, 43 RB, 37 RB Diesel Shovels etc.

KOSI PROJECT :
54 RB, 19 RB Diesel Draglines etc.

DAMODAR VALLEY CORPORATION :
5 W Diesel with Ward Leonard Electric Swing Walking Draglines, 54 RB 54 B Diesel Draglines, 27 RT Blast Hole Drills etc.

MOR CANAL PROJECT :
10 RB, 19 RB, 33 RB Diesel Shovels, Draglines, Clamshells etc.

HIRAKUD PROJECT :
5w Diesel Walking Draglines, 54 RB Diesel Shovels etc.

MACHKUND HYDEL PROJECT :
38 RB Diesel Shovels, Draglines etc.

NAGARJUNSAGAR CANALS :
22 RB Diesel Tunnel Shovels.

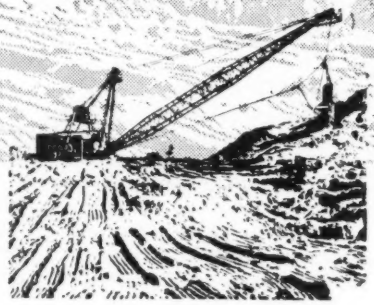
PERIYAR HYDRO ELECTRIC PROJECT :
22 RB and 38 RB Heavy Duty Diesel Shovels, Cranes etc.

TUNGABHADRA HYDEL PROJECT :
33 RB Diesel Shovels, Draglines,
27 RT Diesel Blast hole Drills etc.

MAHI PROJECT :
19, RB Diesel Shovels, Draglines etc.

KOYNA PROJECT :
19 RB Heavy Duty Diesel Tunnel Shovels.

CHAMBAL HYDEL PROJECT :
43 RB Diesel Shovels, Draglines etc.



And many more. A complete list will be provided on request.

BOMBAY
MADRAS
NEW DELHI
KANPUR
BANGALORE
AHMEDABAD
COIMBATORE
RANCHI

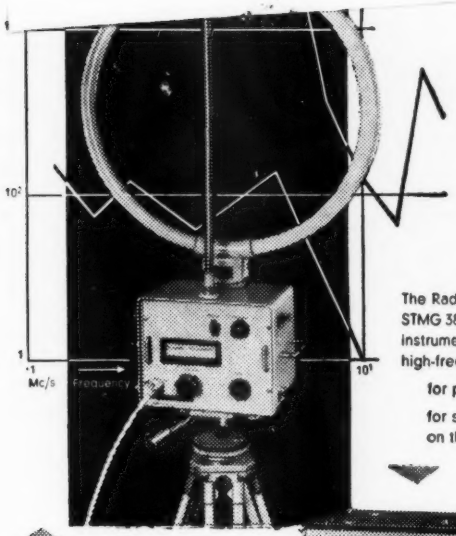
GREAVES COTTON AND CO. LTD. *'A trusted name'*

GREAVES
CENTENARY

Ralli House, 16, Hare Street, Post Box No. 702, Calcutta 1

SIEMENS

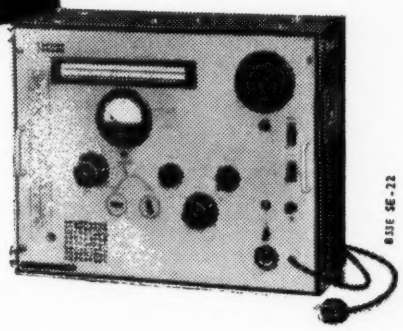
DIO NOISE AND
ELD INTENSITY
METER



The Radio Interference Meter STMG 3800 b is a top quality instrument for measurement of high-frequency radio interference

for precise individual testing

for speedy series measurements on the production line



In connection with the aerial assembly for field strength measurements e.g.

corona testing on High Voltage lines and accessories

on HF and ultra-sonic generators

on spark gaps of all kinds

A comprehensive set of accessories allows universal application of the meter.

We also supply high-grade shielded rooms and anti-interference equipment.

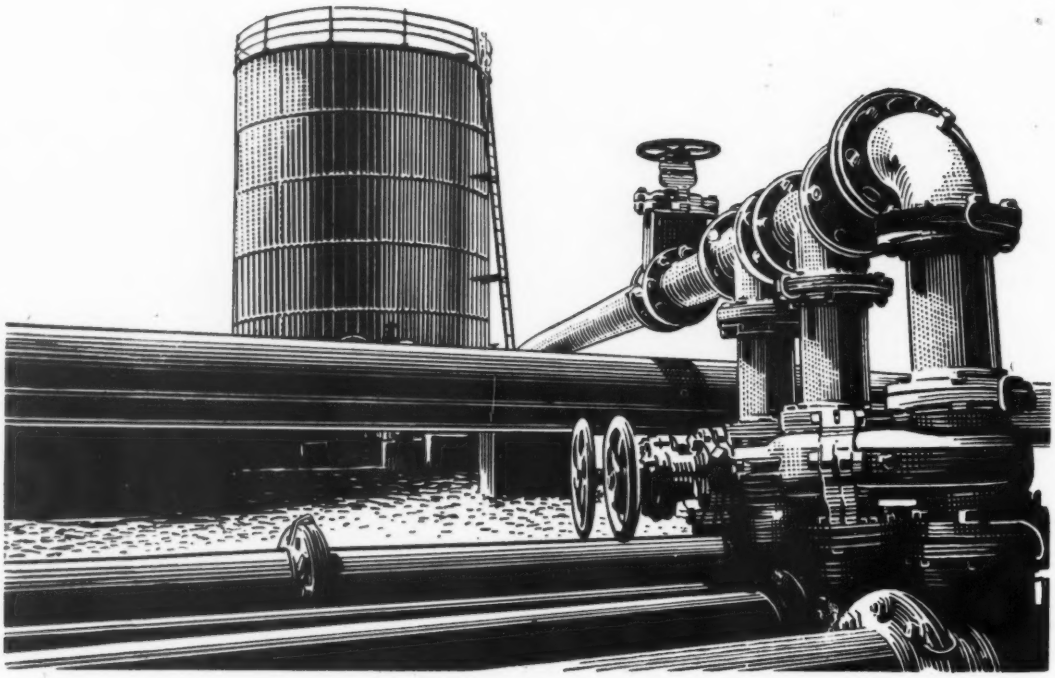
Detailed information sent on request.

SIEMENS & HALSKE AKTIENGESELLSCHAFT
BERLIN • MÜNCHEN

SOLE REPRESENTATIVES
SIEMENS ENGINEERING & MANUFACTURING CO.
OF INDIA PRIVATE LTD.

BOMBAY G.P.O. Box 490 | CALCUTTA Post Box 715 | NEW DELHI G.P.O. Box 543 | MADRAS 36 Mount Road | BANGALORE 9 St. Mark's Road

CAST IRON FLANGED PIPES



Cast Iron Flanged pipes manufactured by The Indian Iron & Steel Company Limited stand up to service conditions where fluids are pumped under high pressure. Made to British Standard specifications under rigid quality control these pipes are able to withstand corrosion for long periods under the most exacting conditions. Specially designed Double Flanged pipes for sand stowing in coal mines are also manufactured by the Company.

THE INDIAN IRON & STEEL COMPANY LIMITED

IISCO

WORKS: BURNPUR & KULTI

Managing Agents :

MARTIN BURN LIMITED

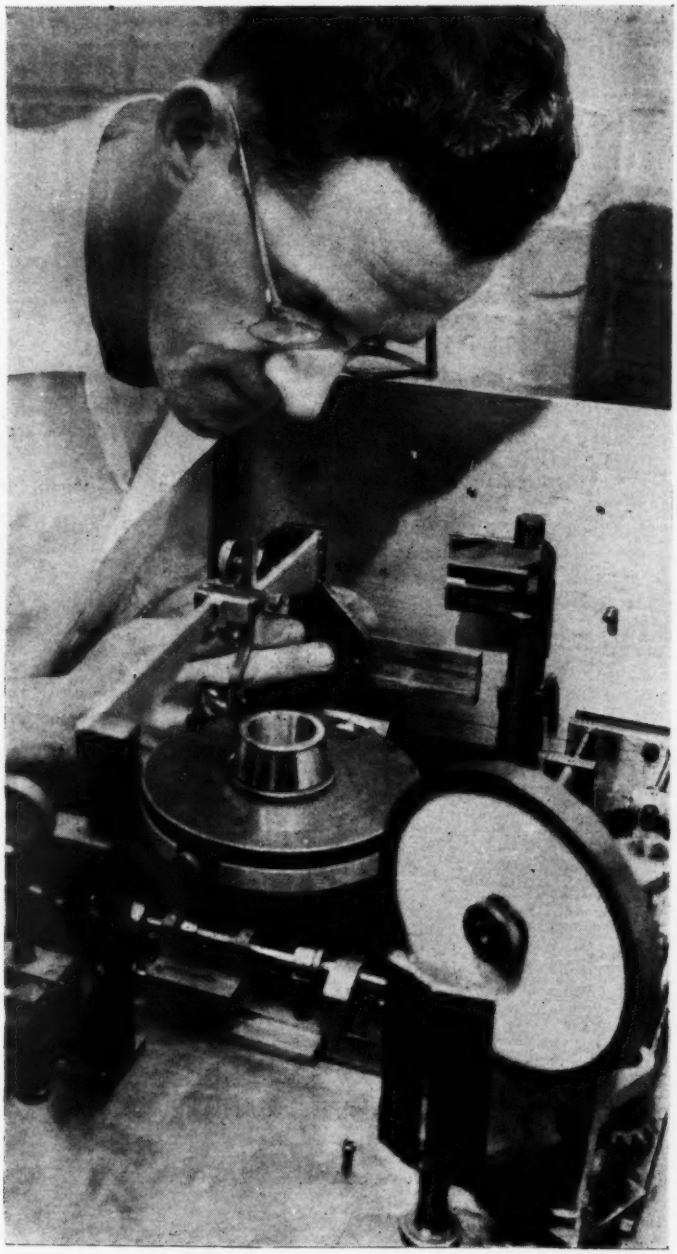
Martin Burn House

12, Mission Row, Calcutta 1.

Branches : New Delhi, Bombay, Kanpur

IIC-79

1
1,000,000 OF AN INCH



The instrument you see here—a profilograph—checks contours and smoothness of circular surfaces to within one millionth of an inch. It's in the gauge laboratory of The Timken Roller Bearing Company's Canton, Ohio plant. It is one of many facilities we use to make all Timken bearings the finest, most precise tapered roller bearings in the world.

And the tapered design of Timken bearings enables them to take loads from *all* directions—something no other type of bearing can do. You'll find Timken tapered roller bearings in the machines produced by leading manufacturers throughout the world.

Look for the trade-mark "Timken" on all the bearings you buy. They're available throughout the world. The Timken Roller Bearing Company, Canton 6, Ohio, U. S. A. Cable address: "TIMROSCO" Timken bearings manufactured in Australia, Canada, England, France and U.S.A.

Industry rolls on

TIMKEN®

REGISTERED TRADE-MARK

tapered roller bearings

Representative: **Muller & Phipps (India) Private Limited.,** Bombay, Madras, New Delhi.

NATIONAL-CL-9-765

If you're buying on a basis of cost-per-yard moved, you'll buy

MARION

EXCAVATORS

Marion Excavators are designed for

- **High production**
- **Low operation & maintenance costs**

BH BLACKWOOD HODGE

BLACKWOOD HODGE

BLACKWOOD HODGE (INDIA) PRIVATE LTD.

MARION

ASSOCIATED COMPANIES BRANCHES WORKS AND AGENCIES THROUGHOUT THE WORLD

MRG/16

PENSTOCKS, PRESSURE SHAFT LININGS
FOR ALL WORKING PRESSURES

GIOVANOLA
Monthey - Switzerland

now made in India!

Wolf DRILLS - GRINDERS
SANDERS - BLOWERS

A wide range now made in India by
Ralliwolf Private Limited in collaboration with
Wolf Electric Tools Limited, London.

Perfectly balanced and with exceptional power to weight ratio, Wolf Portable Electric Tools are packed with power -- with outstanding performance and reliability.

THE FINEST ELECTRIC TOOLS IN THE WORLD

Backed by service after sales

Wolf ELECTRIC TOOLS

Now made in India

Sole Distributors

RALLIS INDIA LIMITED

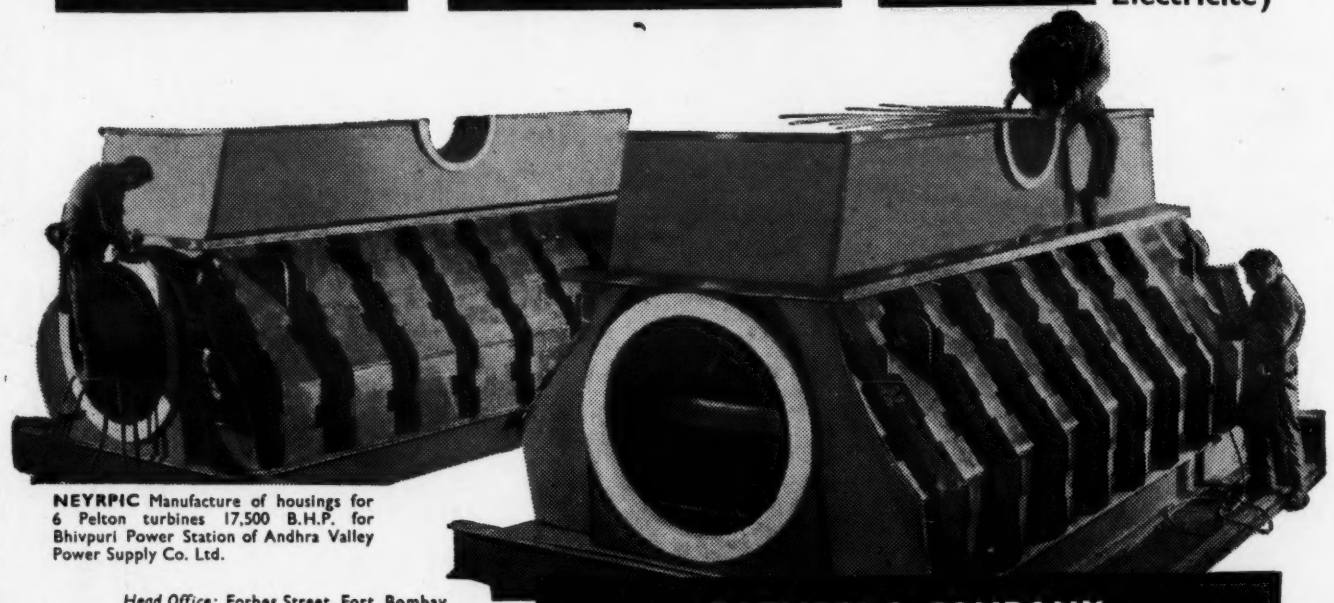
16 Hare Street, Calcutta-1
Bombay - Madras - New Delhi - Kanpur

Accredited dealers throughout India

RWY-1

BATLIBOI & CO. *REPRESENTING LEADING* ***FRENCH*** *MANUFACTURERS*

NEYRPIC **ALSTHOM** **C.G.E.** (Compagnie Générale d' Électricité)



NEYRPIC Manufacture of housings for 6 Pelton turbines 17,500 B.H.P. for Bhivpuri Power Station of Andhra Valley Power Supply Co. Ltd.

Head Office: Forbes Street, Fort, Bombay

Branches: Madras—Calcutta—Delhi—Ahmedabad

Coimbatore—Kanpur—Vijayawada — Secunderabad—Dn.

Associates in Bangalore

BATLIBOI & COMPANY

Proprietors:

BHOGILAL LEHERCHAND PRIVATE LTD.

SISTA'S-B-117

Do you know that Firestone EARTHMOVER TYRES are now all made with Nylon cords?

★ Stronger ★ Tougher ★ Impact Resistant

Firestone proudly announce that all sizes of the Firestone Earthmover tyre and the Firestone Rock Grip Excavator tyre are now being manufactured exclusively with Nylon cords. *

*Nylon cords have greater tensile strength than any other type of fabric used for cords in tyres. Nylon cords are particularly effective in preventing diagonal and X - breaks caused by impacts. They are highly resistant to water and do not deteriorate when exposed to moisture through cuts or snags in the tyre body. Only nylon cords have such high resistance to fatigue from heat.

Because of these characteristics, Nylon cords in your Firestone Earthmover and Firestone Rock Grip Excavator tyres will (1) Reduce danger of blowouts, (2) Reduce failures from heat, (3) Reduce bruise damage, (4) Reduce failures from cuts, and (5) Maintain strength for retreading.

13.00-24	8 & 12 Ply Rating R B.
18.00-24	16, 20 & 24 Ply Rating
18.00-25	12, 16, 20 & 24 Ply Rating
21.00-24	16, 20 & 24 Ply Rating
21.00-25	16, 20 & 24 Ply Rating

Firestone ROCK GRIP EXCAVATOR

also now with Nylon Cords

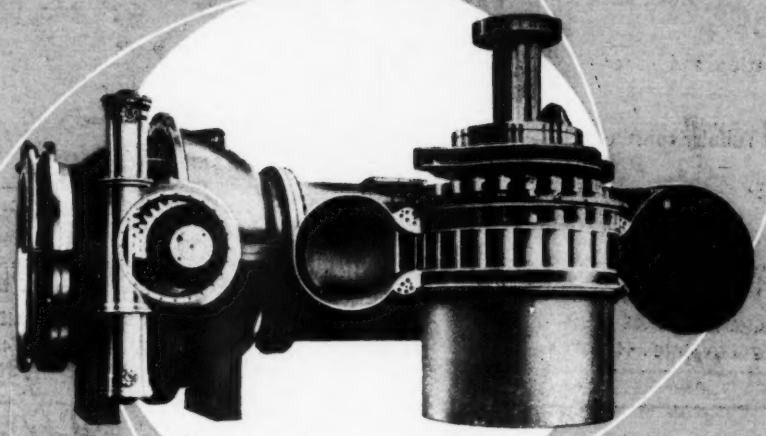
12.00-24	16 Ply Rating
13.00-24	18 Ply Rating
14.00-24	20 Ply Rating

Firestone

Pioneers of the Earthmover Tyre in India

COMPLETE EQUIPMENT

FOR WATER POWER PLANTS



Turbines of the Kaplan, Francis and Pelton type for various heads and outputs, transformers, generators, outdoor and indoor switchgears, control-rooms, etc.

The world renowned SKODA and CKD Trade marks guarantee the first class technical design and quality of equipment supplied by us. We give integral guarantees for complete deliveries.

Local Enquiries to :

SKODA (INDIA) PRIVATE LTD.

Vulcan Insurance Building, Vir Nariman Road, Bombay-1

Branches :

National Insurance Building, Parliament Street, New Delhi

P-38, Mission Row Extension, Calcutta-13

Agurshand Mansion, 35, Mount Road, Madras-2

Delivered by

TECHNOEXPORT

FOREIGN TRADE CORPORATION FOR EXPORT OF COMPLETE INDUSTRIAL PLANTS

56, Vaclavske namesti, Praha-2

CZECHOSLOVAKIA

Fabrication and Erection of complete

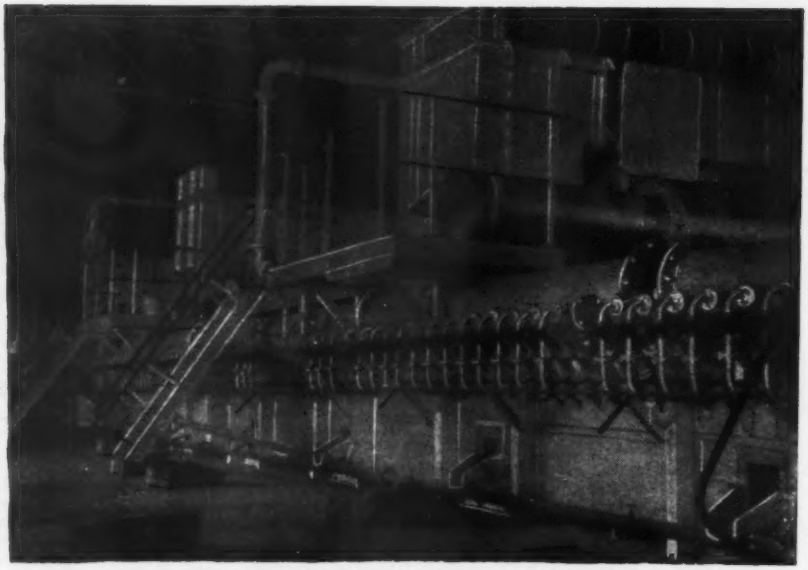
Pipework installations

for Steam, Gas, Compressed Air, Fuel Oil etc.

Coils for Refrigeration and other industrial uses

Light Structures of Tubular construction.

Water Well Casing.



Pipework installation on Fretz Moon Mill, Indian Tube Company (1953) Limited, Jamshedpur.

STEWARTS AND LLOYDS OF INDIA PRIVATE LIMITED

HEAD OFFICE: 41, CHOWRINGHEE ROAD P O BOX 270, CALCUTTA
TELEPHONE . 44-5224 (7 lines) and 44-1451

WORKS: 39, HIDE ROAD, KIDDERPORE, CALCUTTA
TELEPHONE: 45-3515 (3 lines)

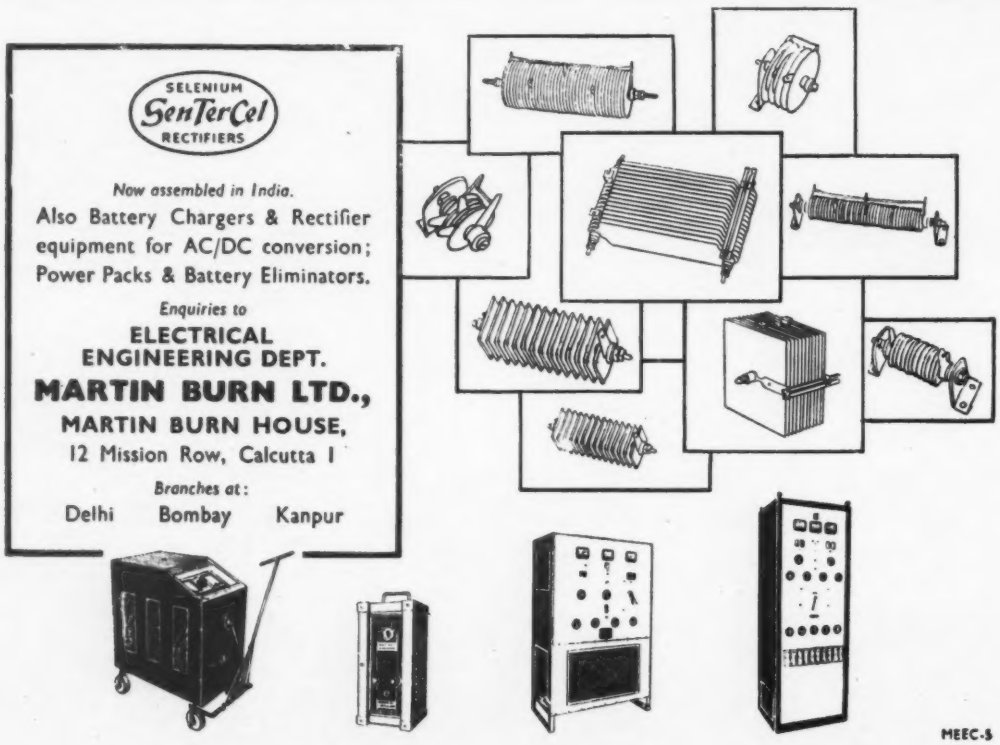
SLF—35/56

SELENIUM
SenTerCel
RECTIFIERS

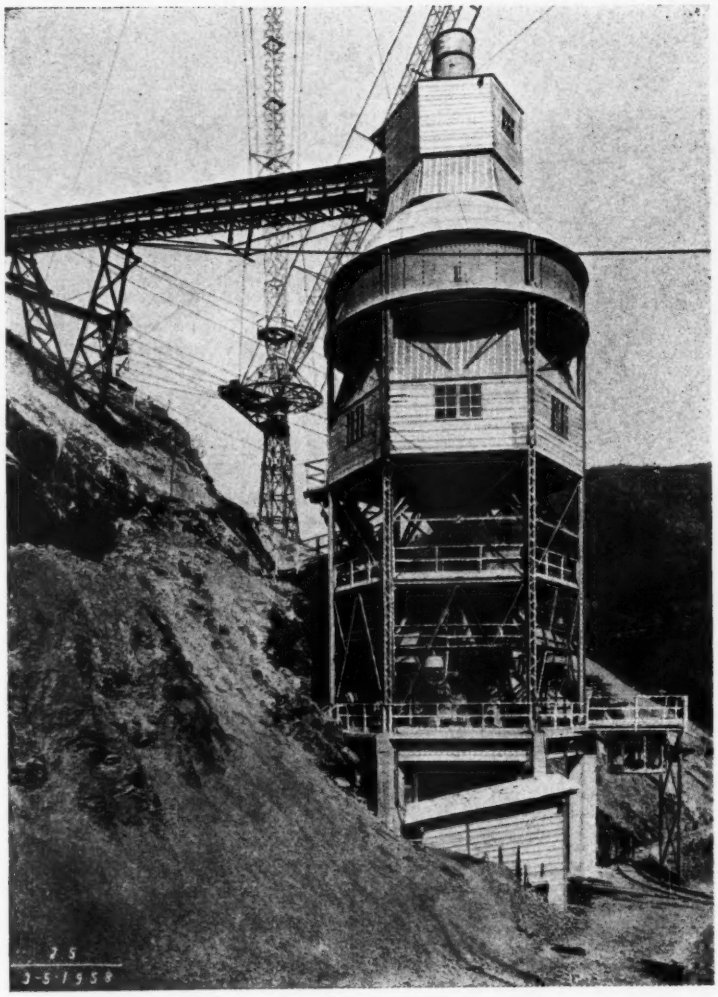
Now assembled in India.
Also Battery Chargers & Rectifier equipment for AC/DC conversion; Power Packs & Battery Eliminators.

Enquiries to
ELECTRICAL ENGINEERING DEPT.
MARTIN BURN LTD.,
MARTIN BURN HOUSE,
12 Mission Row, Calcutta 1

Branches at:
Delhi Bombay Kanpur



MEEC-5



CIFA
MILAN ITALY

Central Mixing Plants and Ready-Mix Plants with Manual and Automatic Controls.

Telescopic Tunnel Steel Forms and Mobile Mixing and Pouring Plants for Tunnel Concrete Lining.

Steel Forms for Dams, Bridges, Silos, Roads, Airports and General Concrete Works.

Steel Beams for Cement and Aggregates.

Bucket Elevators for Cement and Aggregates.

Concrete Buckets Manually and Pneumatically operated.

Screw Conveyors for Cement.

Belt Conveyors for any Length and Capacity.

Pneumatic Conveyors Systems for Cement Transportation.

Sheep-Foot Temping Rollers.

Radio and TV Towers.

High Voltage Transmission Towers.

Write for catalogues and information and send inquiries to :

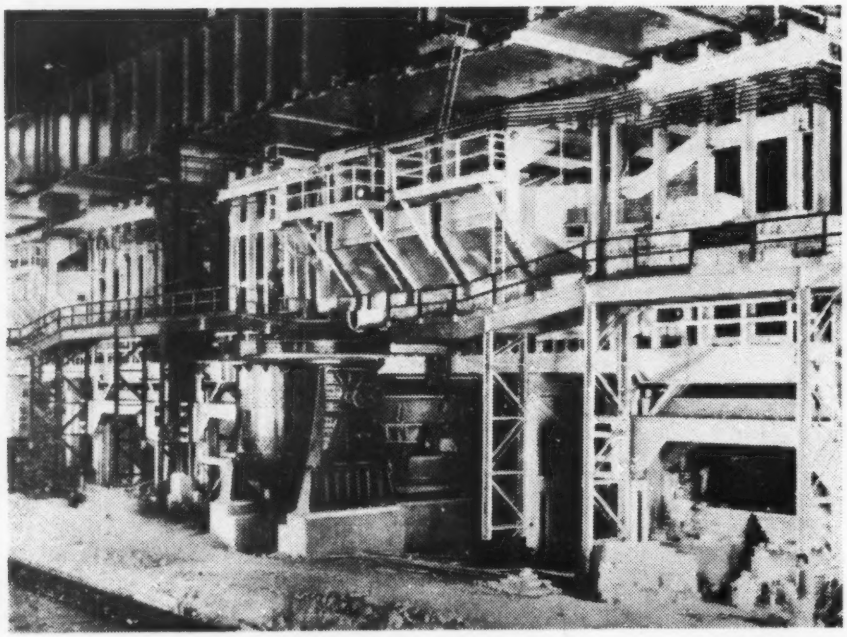
COMPAGNIA ITALIANA FORME ACCIAIO

MILAN - ITALY - VIA BOCCHETTO, 3

Phone : 876'284 - 877'968 Cable : CIFAFORM

REPRESENTATIVES WANTED

Durgapur Steelworks



The Steel Melting Shop

Stage Two—work goes on

Yesterday we surveyed, planned and built .... today results are being obtained. India's newest steelworks at Durgapur, which is being built by ISCON, is now in production under Hindusthan Steel Ltd.

No. 1 Blast Furnace is making iron while work goes on in the second stage, the completion of which will mark the beginning of making and shaping of steel at the steelworks.

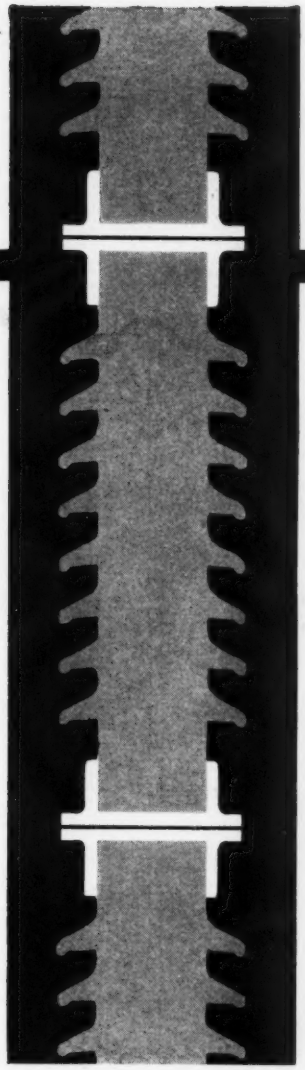
ISCON

INDIAN STEELWORKS CONSTRUCTION COMPANY LIMITED

Davy and United Engineering Company Limited. Head Wrightson & Company Ltd. Simon-Carves Ltd. The Wellman Smith Owen Eng. Corp., Ltd. The Cementation Company Ltd. British Thomson-Houston Co. Ltd. The English Electric Co. Ltd. The General Electric Co. Limited. Metropolitan-Vickers Electrical Export Co. Ltd. Sir William Arrol & Company Ltd. Cleveland Bridge & Engineering Co. Ltd. Dorman Long (Bridge & Engineering) Ltd. Joseph Parks & Son Ltd. Iscon Cable Group (Siemens Edison Swan Ltd. and Pirelli General Cable Works Ltd.)

BRITISH COMPANIES WORKING FOR INDIA

PSIC 10



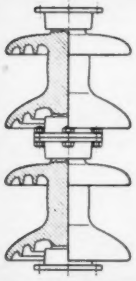
THE NORDEN PORCELAIN FACTORY LTD.
COPENHAGEN · DENMARK

SUB STATION

POST TYPE

INSULATORS

COMPOSED OF
SOLID CORE PORCELAIN UNITS



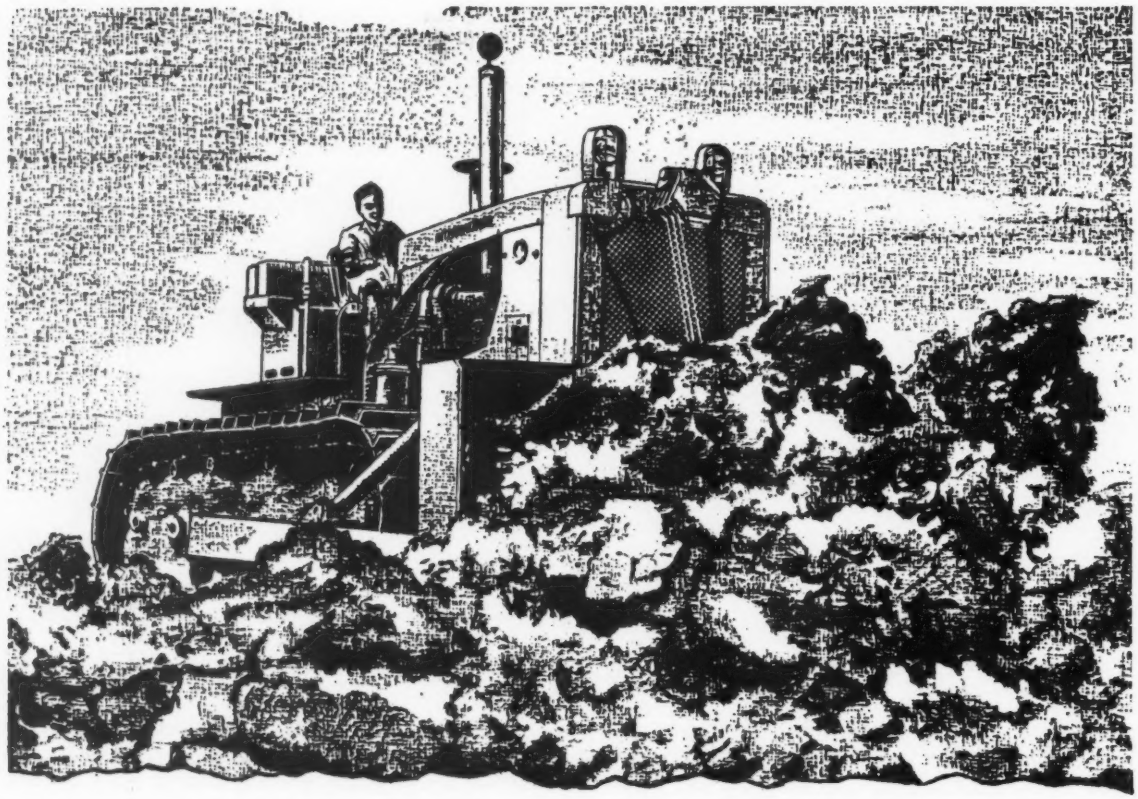
Typical 66 kV stack supplied to:
Mysore State Electricity Board.
Kerala State Electricity Board.
Similar stacks for 66 kV & 110 kV on order for:
Madras State Electricity Board.
Andhra Valley Power Supply Co. Ltd. (Tatas).

REPRESENTATIVES:

LARSEN & TOUBRO LIMITED

POST BOX NO. 278, BOMBAY 1

ALSO AT:
CALCUTTA - NEW DELHI - MADRAS
BANGALORE - COCHIN



It's New! It's Big!

NEW 230 HP INTERNATIONAL TD-25

When tough jobs have to be done at express speed, construction men now call for the International TD-25 diesel tractor—the largest and most powerful crawler of the IH range. Its big turbocharged diesel engine is rated at 230 HP at 1500 rpm (just 60% of its potential 385 HP), sparing a terrific reserve stamina to assure maximum output for continuous trouble-free operation. Construction engineers are realising that the new TD-25 outclasses other crawlers of similar power.

Like other 'International' equipment in India, the TD-25 is backed by Voltas' unrivalled after-sales service and spare parts organisation.

VOLTAS

VOLTAS LIMITED
Construction Equipment Department

Bombay • Calcutta • Madras • New Delhi • Bangalore
Ahmedabad • Secunderabad • Lucknow • Patna • Nagpur

INTERNATIONAL HARVESTER

INDIAN JOURNAL OF POWER AND RIVER VALLEY DEVELOPMENT

A MONTHLY DEVOTED TO DEVELOPMENT OF POWER & WATER RESOURCES IN ASIA

Editor : K. K. Sinha — P. K. Menon : Mg. Editor

VOL. X — MARCH 1960 — NO. 3

CONTENTS

METHODS USED FOR ESTIMATING FUTURE ENERGY REQUIREMENTS AND REASONABLE DEVELOPMENT OF POWER SUPPLY	*J. Klar*	1
ABOUT BACKWATER CURVES IN UNIFORM CHANNELS	*Dr. Ing. P. Franke*	5
BENSON BOILER	*L. N. Misra*	9
HYDRAULIC TURBINES—I	*N. Venkata Row*	13
SOIL INVESTIGATION IN RELATION TO FOUNDATION OF HYDRAULIC STRUCTURES	*Priyatosh Ray*	19
INDUS WATERS TREATY		22
A NOTABLE CONVENTION ON IRRIGATION		24
TECHNICAL NOTES AND NEWS		28
POLICY FOR ATOMIC POWER	*Editorial*	31
OUR CONTRIBUTORS		32

The next Issue will be a Special Number on Kundah Hydro-Electric Project

Editorial and Managerial Offices
6/2, MADAN STREET, CALCUTTA-13. PHONES : 23-1765 & 23-5855. GRAMS : TEKJOURN
Manager : B. Bhattacharya

Bombay Office
41, Hamam Street
Bombay 1
Phone : 252119

German Representatives
Linder Presse Union G. M. B. H.
Frankfurt/Main, Wittelsbacher Allee 60
W. Germany.

London Representatives
Walter Judd Ltd.
47, Gresham Street
London E.C. 2

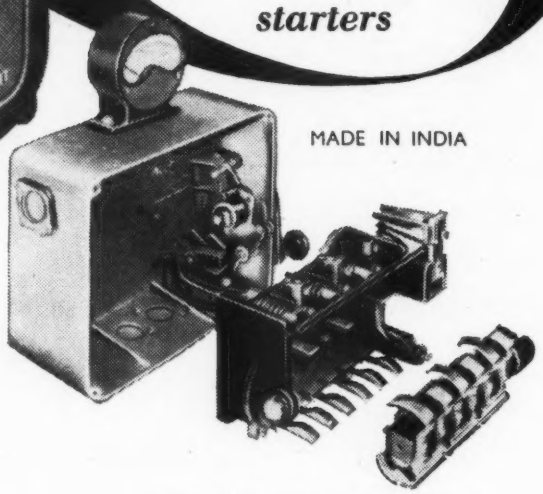
Annual Subscription : Rs. 20, £2 or $6.00. *Single copy : monthly issue* Rs · 2
Back issues at double rates

A GOOD NAME FOR STARTERS

AEI

type ASD air-break star-delta starters

MADE IN INDIA



The reputation of A.E.I. is based on sound engineering design and good workmanship. The standard is maintained in the type ASD series of starters which conform to British and Indian Standard Specifications. They are suitable for squirrel cage motors up to 25 H.P. 650 volts. Write for full technical details.

ASSOCIATED ELECTRICAL INDUSTRIES (INDIA) PRIVATE LTD.

Head Office: Crown House, 6, Mission Row, Calcutta

Branches at :

BOMBAY NEW DELHI MADRAS
BANGALORE COIMBATORE NAGPUR

A. E. I. 'S Light Products **MAZDA LAMPS**

AIC-197

Methods used for Estimating Future Energy Requirements and Reasonable Development of Power Supply

By J. KLAR

The reasonable approach to the technical development of power economy is governed, in the first place, by *the energy requirements of the future. Long-term energy balances* are being prepared all over the world to determine the needs of energy in the future and attempts are made to develop more and more accurate methods to increase the reliability of these balances.

These trends have a special importance in countries poor in energy. The discovery of nuclear energy has raised quite a number of questions in connection with the energy supply of the future as, for instance, finding solutions best suited to local conditions, in order to achieve a reasonable development of long-term power supply.

Though a long-term estimate of the future needs of energy involves difficulties whose solution requires far-reaching theoretical and practical consideration and though the reliability of any estimate decreases with the remoteness of the term, the United Nations Organisation has extended the investigation of power demands as far as the 2000th year.[1]

One of the gravest *difficulties* is the correct assessment of *economic problems* and their effects. This is why in documents of this kind such problems are not dealt with in detail but are just touched upon. Problems of economic character, though difficult to evaluate, do exist and exert their influence, consequently, to study their importance is an imperative task.

A long-term forecast of the power supply in the future requires, first of all, the determination of the *quantity and quality of the needs that are likely to arise*, as well as the *quantity and quality of sources* that are now at our disposal and that can be expected to be available in the future; hence one of the *first* tasks is to prepare a long-term *balance of* the quantity and quality of *energy* to be needed.[2]

Different methods are used for drafting energy balances.

According to *one* of these methods, the following factors are to be taken into account: *the consumption statistics* of the last known year (with due regard to consumption data over a longer period determined in the past), *the available sources of energy, the analysis of the increase of consumption* (including the investigation of the so-called exhaust velocity of the sources), and the consumption to be expected in the future.[3] These data constitute the elements of the balance.

In the foreign literature some authors follow an *optimistic* method, some follow a *pessimistic* method of forecasting.

The *pessimistic method of estimating* the energy potentials reckons with a substantial increase of production, an indutrial, economic, etc. *boom*, on the one hand, and departs from *smaller values* in assessing the resources, on the other.

The *optimistic method of estimating* the energy potentials assumes a relatively *modest* developmentof the *consumption demands*, on the one hand, and departs from *more favourable*, higher values for the resources, on the other.

Unless some apparent reasons prevent us from following it, the middle course between the two methods seems to be expedient.

When drafting energy balances it is usually assumed that the unit cost of energy consumption remains *essentially* unchanged during the period covered by the estimate. This fact considerably decreases the trustworthiness of the energy balances and thereby the authenticity of the estimates of future energy requirements. Especially in Hungary, where the production cost of coal is relatively high a substantial decrease in the cost of energy and the *increase of specific energy consumption* can be achieved by the installation of atomic power stations only.

The energy balances distinguish between energy sources "*introduced*" to the consumer and the types of energy "*utilized*" by the consumer on the spot. (The types of energy introduced are either primary, i.e. basic sources, like coal, crude oil, natural gas, water power, or secondary sources, like electricity, household gas, coke, etc.) This distinction allows of establishing the ratio of energy actually "utilized" by the consumers and of the amount "introduced", i.e. the "*consumption efficiency*", the ratio of secondary and primary energy utilized, i.e. the "*efficiency of energy conversion*", as well as the product of these two efficiencies, i.e. the "*total energy efficiency*".

The energy balances generally take into account *every type of energy*, and are not limited to any one of them (as, for instance, electric energy) because the different types of energy utilized are often interchangeable.

Later we shall come back to the economic significance of the interchangeableness of the types of energy.

The targets set for long-term energy balances are usually approached *from different angles with different methods*, and the results thus obtained are collated and the final decisions taken.

The commonest methods are the following :

(*a*) The so-called *aggregate method* takes into account *vast consumption areas* (e.g.,parts of a country, continents, the whole world) and relying upon the *statistical data of the past* endeavours to deduce certain regularities from the production values of power sources i.e., from the mean values of energy consumption.

Its *advantage* consists in quickly yielding *approximately reliable data* and in showing the summarized result of the influences exerted by the most different *effects* which *compensate each other* fairly *well* over the vast consumption area investigated. The smaller the economic unit investigated with this method. the smaller is the probability of compensation.

Its *drawback* consists in the fact that it is often rather difficult or sometimes even impossible to deduce the reasons of certain important changes from statistical data referring to vast areas.[4]

Different methods can be used for deducting from the data of the past the annual percentage of the increase, for instrance, in of the production the above-mentioned industrial basic energy scurces or in general in the energy requirement of industrial production or of the different branches.[5]

(*b*) Another method of forecasting departs from *assessing the energy consumption of the most important sectors in the national economy* (industry. transport, agriculture, household, etc.) and, relying on these data, tries to make a reasonable estimate of these same energy requirements for the future.

(*c*) With a view to increasing the reliability of the estimated data, *the study of the consumption over areas that can be regarded as energetically homogeneous*, as, for instance, the *industry of electric machinery*, gas production, *steel metallurgy*. etc. might be expedient. Inferences concerning the development of similar power demands in the future can be made from the energy consumption of such areas. *The latter two methods can be called synthetic* because the forecasts rely upon the values obtained from the different branches of industry, i. e. from their areas that csn be regarded as energetically homogeneous.

In calculating average values certain *single factors* must not be lost sight of, like the installation of certain energy-absorbing industries (lightmetal industry, chemical industry), lasting depression, or a sudden boom following the making up for lags caused by possible war-time devastations.[6]

Having now analysed the methods of forecasting we may enquire into the reason *why the economic problems are usually neglected in preparing long term energy balances.*

This may be traced back to several reasons, as for instance, to the partial absence, in the first place, of *reliable unit-price and investment statistics*, and of exact *files on the interchange of the sources of energy as a function of their prices*, etc. In addition to this, even *an approximate accuracy is hardly attainable* in assessing the future effects of quite a number of economic factors which, then, are simply disregarded in order to decrease the vagueness of the estimates.

On the other hand, such an approach to the problem is contradictory because if economic aspects are neglected, the accuracy of the balance and the trustworthiness of the forecast are bound to be impaired. If, for instance, in countries producing today electrical energy from coal at a relatively high price the thermopower plants will be substituted by atomic power stations yielding considerably cheaper energy, then the cheaper production cost of the source of energy and the concomitant decrease in unit cost of electric energy will allow an unforeseeable *increase in the per capita specific consumption of electric energy*. And the past decades testify to the fact that the *utilization of the basic sources of energy is subject to a constant transposition*. The expensive sources of energy (as, e. g. coal) are replaced by less expensive ones (as, e. g. mineral oil or water power) and the consumption conditions are subject to parallel changes following the changes in the production costs of energy.

Important economic interrelations of varying extent at different places and at different times, but not to be neglected in preparing energy balances, appear between the *transposition*, interchange *of the basic sources of energy* and the substitution of expensive ones by cheaper ones, on the one hand, and the *quantity* and *quality of consmption*, on the other.

The next step is to enquire into the *economic significance of the decrease in the unit cost to be expected in the future.*

An American author, P. Sporn[7] states that the *unit cost of electric energy*—in most industries—*is not decisive for the development of the branches* of industry. More important factors are in this respect the *consumption requirements*, the *manpower demands*, the *prices of raw materials*, the *transport costs*, etc., excepting, naturally, the energy-absorbing industries like the electrometallurgy of steel, aluminium metallurgy, etc.

The *increase of energy consumption* is, in his opinion, more the function of the *capital supply* necessary *for new consumer installations.*

Irrespective whether or not this statement holds good for capitalist relations of production, the issue merits as well to be seriously studied and considered.

Sporn's compatriot K.M. Mayer[8] studies *the effect of the decrease in the unit cost of energy in connection with the interchange of power sources.* The power plants having the highest *economic potential* are the most promising for the future. He means the source of

energy, by the use of which *the unit cost of the energy* produced in a given power plant is lower than the unit cost of the energy that can be produced in other power plants by utilizing other sources of energy.

The economic assessment of such problems on a world scale is rendered even more difficult by the fact that the *unit cost of energy*, the *amount of power that can be generated* and, therefore, within the whole national economy, its *significance for the country is extremely variable* (and depends, for instance, on the development of the economic life and on the power reserves of the different countries).

At any rate it would be highly welcome if the organs compiling statistics on power economy (such as the UNO, the OEEC, etc.), beside developing more uniform principles for consumption statistics, were to bestow more care on *compiling statistical data suitable for assessing economic problems, on unifying them and, at the same time, on facilitating international collations*, and to include into the work now done mainly by engineers, such specialists as are well trained in political economics and statistics.

Summing up what has been said above, the *investigation of* the following more important *economic aspects seems to be indcated :*

(*a*) The *effects* of the possible *interchange of the basic sources of energy*, due, in the first place to the changes in their production costs.

(*b*) As to the secondary sources of energy, *the effects of the future inter-relation of the main economic indexes of electrical energy production* as the ratio of *constant* and *variable* costs (e.g., as a result of automatization, the creation of large power plants or large factory units). It remains to see *what part will be played by the cost of fuel* and other expenditures, mainly *costs of investment, in the future development of the unit cost of energy.*

When investigating the cost of *items coming under the heading of investments*, it seems to be expedient to make a thorough study not only of the decrease in the costs to be expected in consequence of the presumable *improvement of efficiency*, but also of the consequences of the decrease in the expenses of *raw materials* (except fuel) *necessary* for power generation, to be expected in the future (e. g., the replacement of metals by synthetic materials).

(*c*) The presumable *effect of the changes in unit cost* of electric energy upon the *requirements of consumption*, upon the development of major industries, including the *energy-absorbing* ones and their influence.

(*d*) Finally, the effects of growing power generation on the increase of the *country's* industrial potential, on *new export possibilities and upon similar but remote economic interconnections.*

If the constant production costs are going to become the decisive factor in the future, the unit cost forecast for electric energy will depend, *in the first place, on further technical development* (the rise of the technical standard) and, to a certain degree, also on the *changes* that are likely to occur *in the prices of* the non-fuel type *raw materials* necessary for power stations.

The *rate of future technical development* and its economic significance—being factors partly depending on discoveries—are *difficult to assess.*

The prices of *raw materials* are likely to change under the decisive influence of the prices of the products manufactured in the synthetic industries now developing with rapid strides and gaining ground all over the world.

A somewhat more reasonable possibility seems to present itself for analysing the *effect of the future decrease in unit costs* upon the development of the consumption within *certain groups of consumers.*

The further development of economic investigations, finally, requires the *establishment of a uniform method for examining the economc efficiency of major investments* (mines, power stations, etc.) *in the energy economy.*

In socialist economy the *economic efficiency* of major investments (such as, e. g. the establishment of power plants) are usually examined from three different angles.

The first angle is *national economy* as a whole, the second is the relevant *industry* and *enterprise* and, finally, the factors enhancing or reducing the efficiency of investments are taken into consideration during *execution* (realization).

The first question to be answered from the angle of national economy in *whether the investment is necessary* and *to what extent* it serves proportional (well-balanced) development of the countries' economic life. Hence the *full social efficiency* of building power plants can only be determined by making allowance for and by estimating every favourable (active) and unfavourable (passive) effect it may have upon satisfying in the long run all necessary social requirements.

When complying, to a certain extent, with certain investment requirements in energy economy (active effect), it should be realized what other important branches of the natioal economy may fall short of certain investments (passive effect).

Hence, the first thing to be settled is the *order of importance* of the investment requirements to be met and then the order of magnitude of the investments to be remarked for the different branches.

The decision concerning the branch of industry or, even more so, enterprise, will be taken according to the *most expedient form* (for instance, thermo-or hydro-power plant) the investment found necessary can assume. In this respect we suggest the use of Prof. Strumilin's method for determining the coefficient (*d*) of the relative efficiency which examines the

ratio of operation thrifts of collated schemes and of the *surplus investments* rendering them possible.

The *inverse value* of Strumilin's coefficient of the relative efficiency yields the so-called *time of recovery*, i.e. the term within which the surplus investment is recovered as a result of the reduction of production costs.

According to this method the decisive index of economicalness is the annual reduction of production costs calculated for one currency unit. Hence where

$$\delta = \frac{C_1 - C_2}{I_2 - I_1}$$

C_1 and I_1 are the investment costs and the production costs, respectively, of the minimum version of the plan, and C_2 and I_2 are the investment costs and production costs, respectively, ensuring higher technical standard (consequently, reduced production costs)

The inverse form of the equation

$$\frac{I_2 - I_1}{C_1 - C_2} = \frac{1}{\delta}$$

expresses *in years* the time within which the investments are recovered.

It is obvious that when investigating economicalness *factors and relations other than this index should also be assessed correspondingly.*

Only by considering all relevant factors can be obtained a clear picture and a solution most favourable for the national economy.

Then we proceed to investigate the factors that might increase the *costs of realizing the scheme* found most suitable and to consider the outcome of these investigations. (Such as the possible term of realization connected with the consequences of the natural conditions, the most suitable way of meeting power requirements, control of *safety in planning.*)

Hence *the meticulous disclosure of economic relations* and their correct assessment *in preparing long-term energy balances*,--even if their evaluation is an intricate and difficult task full of contradictions—*can by no means be neglected, though it must be admitted that owing to their uncertainty sometimes they are much less suitable to be expressed in figures than the deducions that can be made from the data of past consumption, from the estimate of energy sources or from the rate of exhaustion.*

When preparing long-term energy balances it must, however, be kept in mind that forecasts—even if yielding indispensable information for the planned development of the energy economy,—are by nature of but a *vaguely informative character*, and the data obtained thereby, being variable in time, require a manysided evaluation and careful circumspection.

Since, in spite of their deficiencies, they are for the time being indispensable in planning, constant attempts should be made to improve the investigation methods and the collecting of data. Finally, beside the more or less measurable economic aspects, planning must also rely on the effects of development that cannot be expressed in figures but to a certain extent can be deduced from experimental facts.

REFERENCES

1 United Nations, *World Energy Requirements in* 1975 *and* 2000. Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. I, p/902, New York 1956.

2 Rational methods for drafting long-term energy balances have been discussed lately by Andras Levai, professor at the Technical University, Budapest in his *A magenergiahacznositas varhato szerepe Magyarorszag tavlati energiamerlegeben* (The Possible Influence of the Utilization of Nuclear Energy on the Long-term Energy Balance of Hungary), published for official information. I shall discuss the drafting of long-term energy balances after prof. Levai.

3 Another method expounded in an OEEC report (The Organisation for European Economic Co-operation, *Europe's Growing Needs of Energy*, Paris 1956) suggests the estimate to be based on the following data: the *gross national income* and the *energy consumption to be expected*, making a preliminary estimate of them for the whole area of the OEEC Member countries on the basis of the present rate of employment, taking into account the growth of the population, the number of working hours and the changes occurring in productivity. A further step is to estimate the increase of energy demands to be expected for industrial and household consumption. The last step is to sum up the estimates concerning the different countries.

4 Relying upon statistics reaching back into the remote past, aggregate method may yield an interesting set of data concerning the *degree of utilization of the aggregate basic sources of* (industrial) *energy of the world and its energy consumption* (coal, liquid fuel, natural gas, water power). See United Nations, *World Energy Requirements in* 1975 *and* 2000, Proceedings of the International Conference on the Peaceful Uses of Atomic Energy.

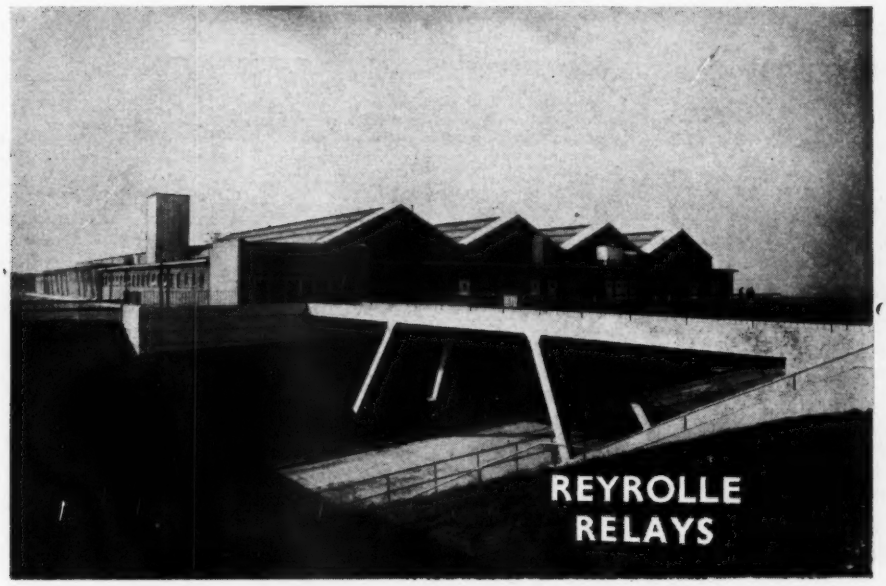
On examining the data for the period between 1863 and 1953, it becomes obvious that wars, economic crises and the years of prosperity involve booms and slumps in the development. Within the above-mentioned period, in the years of economic prosperity the annual increase of the total energy production was 4.5, i.e. 5.5 per cent, while including the years of regression the average increase of the production of industrial energy sources, uniformly calculated, was not higher than 3.25 per cent. For the same ninety-year period, in the *United States*, the production of industrial energy sources show an average increase of 4.7 per cent per annum, whereas the production of all energy sources during the same period increased by no more than 2.5 per cent.

In the OEEC countries the annual increase of energy consumption was 4.8 per cent after 1945 which, of course, includes post-war restoration. See The Organisation of European Economic Co-operation, *Europe's Growing Needs of Energy*, Paris 1956.

The average increase in the *production of all energy sources in Great Britain*, taking into account the domestic consumption, was 1.85 per cent between 1850 and 1950. See G. H. Daniel, *The Energy Requirements of the United Kingdom*, Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 1,P/388, New York 1956. The annual increase of the aggregate energy consumption in *Europe* (without the USSR) was 1.6 per cent for the period of 1925-1953. See *The Electric Power Situation in Europe in* 1955, Economic Commission for Europe, Committee on Electric Power. EP Working Paper No. 61. 4 Oct. 1956.

5 P. Ailleret, *Estimates of Energy Requirements*, Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol. 1, P/326, New York 1956.

[*Continued on page* 7



All types
for separate sale

The Reyrolle Light Engineering Shop has been specially designed for the manufacture of relays and instruments. It includes, under one roof, its own machine-shop, plating-shop, paint shop, coil-winding and impregnation areas, assembly and testing areas, and separate sections for storing raw materials and finished parts.

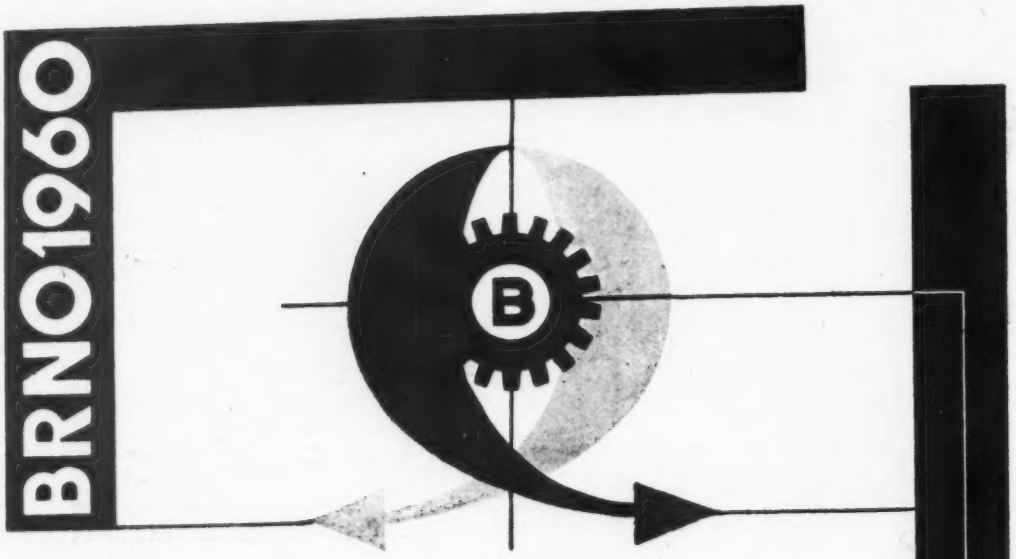
Reyrolle

A. REYROLLE & COMPANY LIMITED - HEBBURN - COUNTY DURHAM - ENGLAND

Send your enquiries to :

BURN & CO., LTD.
CALCUTTA BOMBAY NEW DELHI KANPUR

BOMBAY CO. (PTE.) LTD.
MADRAS & SOUTHERN INDIA



11TH TO 25TH SEPTEMBER, 1960

Rising production requires increased sales.
That is the reason
why also your firm should participate in the

INTERNATIONAL FAIR IN BRNO.

Products of the engineering and metallurgical industries, raw materials and semi-products for the engineering industry, engineering products of a consumer goods character.

Further information will be supplied by

BRNO TRADE FAIR
Brno, Czechoslovakia

BRNO

1960 BVV

About Backwater Curves in Uniform Channels

By Dr. ING. P. FRANKE

GENERAL FEATURES

Particular cases of the steady non-uniform flow are those with a throughout positive or negative acceleration along a certain course. Then, in relation to a steady uniform flow, the water surface profile in the longitudinal section is either falling or rising.

In steady accelerated flow the mean velocity increases continuously and therefore the water depths are diminishing accordingly. The line of the water level is called falling-curve (fig. 1). On the other hand, in steady retarded flow the mean velocity decreases continuously and subsequently the water depths are increasing. This line of water level is called rising-curve (fig. 2)

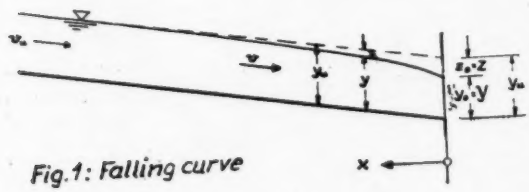
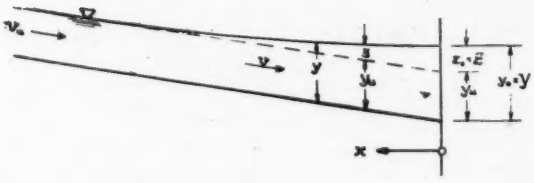


Fig. 1: Falling curve

Fig. 2: Rising curve



The differential equation for steady non-uniform flow can be integrated for backwater curves, assuming a uniform channel profile without berms. Omitting the influence of the velocity head, the solution will be expressed in general terms of

$$x = \frac{y_u}{J_s} \left[\Phi_1 - \Phi_2 \right]$$

The backwater functions Φ are given in tables or diagrams. These values are naturally dependent on the presumptions concerned.

It may be noted that for rising-curves, where the range of velocity is to be expressed as

$$v_u \geqq v \underset{(=)}{>} 0$$

the influence of kinetic energy will be relatively small. For complete falling-curves, however, this approximation is somewhat rough, as the range of velocity is given by

$$v_u \leqq v \leqq v_c$$

where v_c is the critical velocity immediately upstream of the drop. With the simplified calculations in omitting the velocity head, the lengths obtained are always somewhat bigger than those with regard to the influence of the kinetic energy.

As the theoretical end of backwater curves is in the infinite, the practical end is usually assumed where the difference of water level is approximately 1% in relation to that of uniform flow.

It seems advantageously to compare some of the existing backwater functions with regard to the results of application.

RISING CURVES

With the symbols of figure 2, for the determination of any length from the weir, the expression

$$x = \frac{y_u}{J_s} \left[\Phi \left(\frac{y_o}{y_u} \right) - \Phi \left(\frac{y}{y_u} \right) \right] \qquad (1)$$

will be obtained. Naturally all other desired values can be worked out if in general it will be written

$$y_{n-1} \text{ for } y_o \text{ and } y_n \text{ for } y$$

hence $\triangle x = x_n - x_{n-1}$.

For the total lengths of the curve up to the section with the relation $z = 0.01\ y_u$ and $y/y_u = 1.01$ respectively, follows the expression

$$X = \frac{y_u}{J_s} \left[\Phi \left(\frac{y_o}{y_u} \right) - \Phi\,(1{,}01) \right]. \qquad (2)$$

Assuming that the backwater function $\Phi\,(1.01)$ can be neglected, or the main function may be reduced accordingly, the simplified relation

$$X = \frac{y_u}{J_s} \Phi \left(\frac{y_o}{y_u} \right)$$

will be obtained, which may be expressed in general as

$$X = \frac{y_u}{J_s} \Phi \left(\frac{y}{y_u} \right) \qquad (3)$$

applicable for the determination of the backwater length from any section having the depth y, up to the presumed practical end of the curve upstream.

Substituting the term

$$\frac{y}{y_u} A = \Phi \left(\frac{y}{y_u} \right)$$

it follows the modified equation

$$X = A \frac{y}{J_s} = A \frac{y_u + z}{J_s} . \qquad (4)$$

The length from the weir up to any section (n) will be expressed by

$$x_n = X_\circ - X_n = \frac{1}{J_s} (A_\circ y_\circ - A_n y_n) \qquad (5)$$

Further, the length between any two sections or depths for certain lengths may also be found out. Reference values of the factor A are noted in table 1. (see end of article).

With an other analogous substitution as

$$\frac{z}{y_u} B = \Phi \left(\frac{y}{y_u} \right)$$

the modified relation

$$X = B \frac{z}{J_s} = B \frac{y - y_u}{J_s} \qquad (6)$$

will be obtained. Some reference values of the factor B are given in table 2.

The modified backwater functions A and B are tabulated as follows :

(1) Method by Dupuit—Rühlmann (1863/80), derived for channels with a large rectangular cross-section and using the velocity formula by Brahms—Chézy.

(2) Method by Tolkmitt (1892) for flat parabolic profiles and using the formula of velocity by Brahms—Chézy.

(3) Method by Schaffernak (1914) for wide rectangular sections and introducing the velocity formula by Hermanek, which is convenient for large rivers.

(4) Method by Ehrenberger (1914) for approximatively rectangular channels with the formula of velocity by Gröger.

(*a*) Depths $y_u > 2$m.
(*b*) Depths $y_u < 2$m.
(*c*) Velocity formula by Forchheimer.

(5) Method by Bakhmeteff (1932) for prismatic sections having different values of the so-called hydraulic exponent n.

(*a*) Profiles with n=3 (large rectangular sections).
(*b*) Profiles with n=4 (parabolic sections).
(*c*) Profiles with n=5 (triangular sections).

Introducing the conveyance factor K, as

$$Q = F v = F C \sqrt{R J} = K \sqrt{J}$$

which in a reasonable range of depths follows sufficiently close to an exponential relation, expressed by

$$K^2 = Q^2/J = F^2 C^2 R = \propto y^n .$$

Bakhmeteff published the backwater functions for the range of $2.8 \leqq n \leqq 5.4$.

The method by Baticle (1921) for triangular profiles presents the same values as Bakhmeteff's method with n=5.

Values of the factor B were already worked out by Faber (1903), based on Rühlmann's backwater functions with regard to the corresponding value $\Phi(1.01) = 0.007$. Further, such factors are given by Marzolo (1941) which are in fair accordance with those computed with Schaffernak's functions.

It is obvious from table 1 that the values A are varying in a relatively small range only, especially for relations $y/y_u > 2$. The differences are dependent on the particular method and on the presumed practical end of the backwater curve. For this end-section the relation y/y_u is mainly assumed between 1.015 and 1.005. The values by Schaffernak for example, are worked out up to $y/y_u = 1.015$. As all these methods are approximations only, the application of mean values of A may be sufficient for such computations. These factors are included in table 3. For relations $y/y_u > 1.8$ it follows A=1 and subsequently for the lengths the simplified expressions

$$X = \frac{y}{J_s} \qquad (4a)$$

and

$$x_n = \frac{y_\circ - y_n}{J_s} \qquad (5a)$$

may be applied.

From the relations of Φ, simplified expressions for A will be obtained neglecting the terms of small order. It follows from Schaffernak's derivation

Table 1 : *Reference values of the factor A.*

$\frac{y}{y_u}$	*Rühlmann*	*Tolkmitt*	*Schaffernak*	*Ehrenberger* (*a*)	(*b*)	(*c*)	*Bakhmeteff* $n=3$	$n=4$	$n=5$
1,01	0,01	0,07	−0,10	0,10	0,18	−0,10	0	0,10	0,33
1,05	0,54	0,48	0,36	0,40	0,46	0,32	0,54	0,48	0,64
1,10	0,76	0,64	0,55	0,57	0,62	0,52	0,75	0,64	0,77
1,20	0,95	0,79	0,72	0,74	0,78	0,69	0,94	0,79	0,87
1,30	1,03	0,86	0,80	0,83	0,85	0,78	1,03	0,86	0,92
1,40	1,08	0,90	0,86	0,88	0,89	0,84	1,07	0,91	0,95
1,50	1,11	0,93	0,89	0,91	0,92	0,88	1,10	0,93	0,97
1,60	1,12	0,95	0,91	0,93	0,94	0,91	1,12	0,95	0,98
1,70	1,13	0,96	0,93	0,94	0,95	0,92	1,13	0,96	0,98
1,80	1,14	0,97	0,94	0,95	0,96	0,94	1,14	0,97	0,99
1,90	1,14	0,97	0,95	0,96	0,97	0,95	1,14	0,97	0,99
2,00	1,14	0,98	0,96	0,97	0,98	0,96	1,14	0,98	0,99
2,20	1,14	0,99	0,97	0,98	0,98	0,97	1,14	0,99	0,99
2,40	1,14	0,99	0,98	0,99	0,99	0,97	1,13	0,99	1,00
2,60	1,13	0,99	0,98	0,99	0,99	0,98	1,13	0,99	1,00
2,80	1,12	0,99	0,99	0,99	0,99	0,99	1,12	0,99	1,00
3,00	1,12	1,00	0,99	0,99	1,00	0,99	1,12	1,00	1,00
3,50	1,11	1,00	0,99	0,99	1,00	0,99	1,11	1,00	1,00
4,00	1,10	1,00	1,00	1,00	1,00	1,00	1,10	1,00	1,00
4,50	1,09	1,00	1,00	1,00	1,00	1,00	1,09	1,00	1,00
5,00	1,08	1,00	1,00	1,00	1,00	1,00	1,08	1,00	1,00
10,00	1,04	1,00	1,00	1,00	1,00	1,00	1,04	1,00	1,00

Table 2 : *Reference values of the factor B.*

$\frac{y}{y_u}$	$\frac{z}{y_u}$	*Rühlmann*	*Tolkmitt*	*Schaffernak*	*Ehrenberger* (*a*)	(*b*)	(*c*)	*Bakhmeteff* $n=3$	$n=4$	$n=5$
1,05	0,05	11,40	10,00	7,40	8,55	9,70	6,40	11,30	10,00	13,50
1,10	0,10	8,35	7.08	6,00	6,31	6,81	5,60	8,30	7,08	8,45
1,20	0,20	5,68	4,74	4,30	4,47	4,65	4,15	5,65	4,74	5,25
1,30	0,30	4,48	3,73	3,47	3,58	3,67	3,40	4,44	3,73	4,00
1,40	0,40	3,78	3,15	3,00	3,06	3,12	2,95	3,77	3,17	3,32
1,50	0,50	3,34	2,78	2,68	2,72	2,76	2,64	3,32	2,78	2,89
1,60	0,60	3,00	2,52	2,43	2,48	2,51	2,42	3,00	2,52	2,60
1,70	0,70	2,75	2,33	2,26	2,29	2,32	2,23	2,74	2,33	2,39
1,80	0,80	2,56	2,18	2,12	2,15	2,17	2,11	2,57	2,18	2,22
1,90	0,90	2,41	2,06	2,02	2,03	2,05	2,00	2,40	2,06	2,09
2,00	1,00	2,28	1,96	1,93	1,94	1,95	1,92	2,28	1,96	1,98
2,20	1,20	2,09	1,81	1,78	1,79	1,80	1,78	2,08	1,81	1,82
2,40	1,40	1,95	1,70	1,68	1,69	1,70	1,67	1,94	1,70	1,71
2,60	1,60	1,84	1,61	1,60	1,61	,61	1,60	1,83	1,61	1,62
2,80	1,80	1,75	1,55	1,54	1,54	1,54	1,54	1,75	1,55	1,55
3,00	2,00	1,68	1,50	1,49	1,49	1,49	1,49	1,68	1,49	1,50
3,50	2,50	1,55								
4,00	3,00	1,46	1,33	1,33	1,33	1,33	1,33	1,46	1,33	1,33
4,50	3,50	1,40								
5,00	4,00	1,35	1,25	1,25	1,25	1,25	1,25	1,35	1,25	1,25

Table 3 : *Mean values of the factor A.*

$\frac{y}{y_u}$	A
1,10	0,65
1,20	0,81
1,30	0,88
1,40	0,93
1,50	0,96
1,60	0,98
1,70	0,99
1,80	1,00
1,90	1,00
$\geq$ 2,00	1,00

$$A=1-\frac{1}{2.50}\left(\frac{y_u}{y}\right)^{3.50} \qquad (7)$$

and from Ehrenberger's method, with introduced mean values out of the two relations with Groger's formula, the expression

$$A=1-\frac{1}{2.75}\left(\frac{y_u}{y}\right)^{3.75} \qquad (8)$$

will be obtained. These two formulae are applicable for relations $y/y_u > 1.01$ only.

Illustration

Given : $y_u = 0.50$ m $\quad J_s = 1.50‰$

$z_\circ = 1.00$ m $\quad y_\circ = 1.50$ m.

It may be worked out:

(1) The total length of the backwater curve.
(2) The length up to the section (n) having $z=0.50$ m and $y=1.00$ m.
(3) The water depth 200 m upstream the weir.

Computations :

$$\frac{y_\circ}{y_u}=\frac{1.50}{0.50}=3\,; \qquad \frac{y_n}{y_u}=\frac{1\,00}{0.50}=2\,.$$

For both the sections follows from table 3 the value $A=1$.

(1) $$X=\frac{y_\circ}{J_s}=\frac{1.50}{0.0015}=1000 \text{ m}.$$

With the values A from table 1, the lengths obtained are between 1120 m and 990 m.

(2) $$x_n=\frac{y_\circ-y_n}{J_s}=\frac{1.50-1.00}{0.0015}=333 \text{ m}.$$

Applying formula (5) and the factors from table 1, the lengths are varying between 360 m and 350 m.

(3) $$y=y_\circ-x\,J_s=1.50-0.30=1.20 \text{ m}.$$

With the values of A from table 1, it follows

$$A\,y=A_\circ\,y_\circ-x\,J_s$$

and practically the same depth will be found out.

FALLING CURVES

For falling curves analogous values can be worked out from the various methods. However, with regard to the relatively short lengths of such curves and, considering the fact that the velocity head may not be neglected, more exact computations are preferable.

CONCLUSION

For approximate determinations of rising curves the influence of kinetic energy may be neglected. Various methods, using backwater functions, are developed for channels of uniform section. However, it is possible to apply simplified formulae disregarding the other particular presumptions, because all these methods are approaches only.

The introduction of additional factors for greater accuracy can not be considered as an advantage. For such purposes, the calculation with the step-by-step method becomes most convenient; moreover, any quantity can be changed independently of the others for any section. Therefore it is universally applicable for gradually varied flow in open channels.

REFERENCES

Bakhmeteff, B : Hydraulics of Open Channels. New York and London, 1932.
Forchheimer, Ph.: Hydraulik. Leipzig, 1930.
Franke, P.: Berechnung der Wasserspiegellage für die stationär ungleichförmige Strömung in offenen Gerinnen. Stuttgart, 1950.
Scimemi, E.: Compendio di Idraulica. Padova, 1955.
Supino, G.: Lezioni di Idraulica, Bologna, 1954.
Franke, P.: Determination in Stages of the Water Level in Steady Non-uniform Flow.
Indian Journal of Power and River Valley Development 12 (1959) No. 10.

[*Continued from page 4*

Methods used for Estimating Future Energy Requirements and Reasonable Development of Power Supply

6 The report of the Economic Commission for Europe, for instance, divides the aggregate consumption into *industrial, transport, household* sectors and *losses* (*La Situation de l'energie electrique en Europe en* 1953/54, Commission economique pour l, Europe, Comite, de l'energie electrique, EP/82, 28 janvier 1955) and analyses the increase of consumption for the years 1928 to 1953. Accordingly the total increase of electric energy consumption during these years was 5.5 per cent/annum, that of the industrial consumption 5 percent/annum of transport 1.7 per cent/annum, the losses amounted to 5.6 percent/annum, and the figure for household consumption was 7.5 per cent/annum. This conspicuous development can be accounted for by the inclusion of new household consumers, on the one hand, and by the new demands of the earlier consumers.

7 P. Sporn, *The Role of Energy and Nuclear Energy in the United States*, Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Vol.1, P/468, New York 1956.

8 K. M. Mayer, *The Economic Potential of Nuclear Energy*, Proceedings of the International Conference on the Peaceful Uses of Atomic Energy. Vol 1, P/475, New York 1956.

[*By Courtesy of Periodica Polytechnica, Budapest.*]

proved by the severest of tests...

approved by the discriminating engineer

ICC

PARAMITE · PARAMEX · CABLECO

- PARAMITE RUBBER INSULATED CABLES FOR ALL INDUSTRIAL, DOMESTIC AND AGRICULTURAL PURPOSES.
- PARAMEX SYNTHETIC ENAMELLED COPPER WIRES
- CABLECO BARE CONDUCTORS SOLID COPPER, STRANDED COPPER SOLID ALUMINIUM, STRANDED ALUMINIUM AND ACSR.
- PAPER INSULATED POWER CABLES UP TO 11, KV.

THE INDIAN CABLE COMPANY LTD.

9, HARE STREET, P. O. BOX 514, CALCUTTA

Representatives in India for

BRITISH INSULATED CALLENDER'S CABLES LTD.

BRANCHES :

AHMEDABAD, BANGALORE, BOMBAY, COIMBATORE, JAMSHEDPUR, KANPUR, MADRAS, NAGPUR, NEW DELHI AND SECUNDERABAD

CABLES

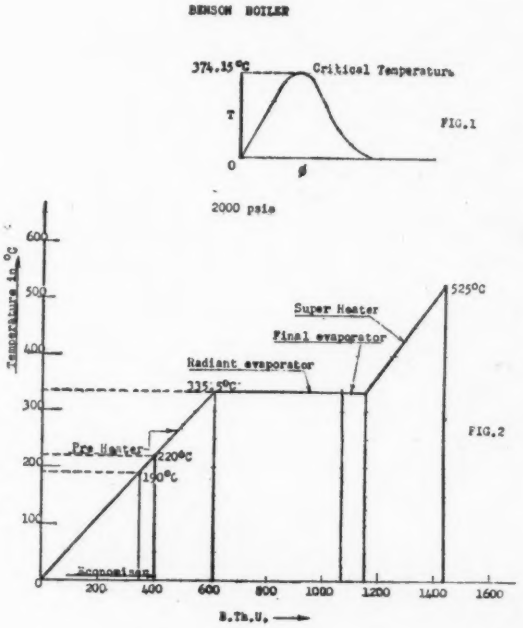
IC-17

Benson Boiler

By L. N. MISRA

Every industrially advanced country has been endeavouring to generate cheaper power which is one of the main raw materials for the industry. Most of the countries had to rely on coal for power generation. This led to the development of boilers which accounts for nearly 30% of the capital investment of a moderate size steam power station. A boiler, rather steam generator, generates steam under presssure from coal, air and water.

There are mainly two types of steam generators in common use—Natural Circulation and Forced Circulation. The latter had been developed from the idea of critical pressure. It is the inherent property of water that at the critical pressure and temperature it directly converts itself into dry steam without ebullition. A look at the T—Φ diagram explains the above



principle. At 374.15°C, the water and dry steam lines join. This phenomenon gave a novel idea to Mr. Mark Benson and so this type of boiler has been named after him. The critical pressure was maintained by a throttle valve which was in the middle of the superheater. The technical development at that time did not allow to build turbines for such high pressures, but later it was found that this boiler can be operated efficiently even at low pressures. Though the idea of Benson boilers was conceived much earlier, yet the 1st Benson steam generator was put into operation much later in 1927 by Siemens-Schuckertwerke AG, West Germany—the wellknown pioneers in the field of steam power and electrical machinery manufacture. The patent right for this type of boiler is also held by them.

The Benson boiler is a forced circulation 'once-through' (water enters at one end of a tube and leaves it at the other end as superheated steam) type. Hence, the boiler does away with the water gauges. The drums are also not required. This makes it obvious

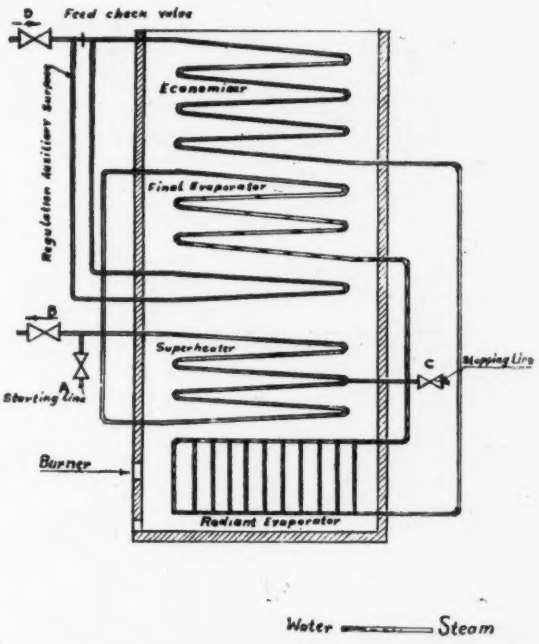


Fig. 3

that there are no extra heavy materials. As the boiler is a continuous bundle of tubes which are of smaller diameter than those of a similar capacity natural circulation boiler, the total weight of it is less than the other contemporary types. The Benson boiler is so designed that about 80 to 85% of feed water is evaporated in the hottest zone of the combustion chamber. The mixture of steam and water consequently passes through zones of lower temperature to complete the final evaporation (refer to dia. II and III). Naturally, depending upon the feed water chemical contents, salt deposit will be only in this final evaporator and the equivalent part in the super-

critical boiler is the so-called "Transition Zone". Boilers are normally flushed out after 4000 total working hours to remove salt. This can be effected during short shut down of boilers.

The various parts e.g., preheater, radiant evaporator, final stage evaporator and superheaters are nothing but bundles of tubes. The furnace chamber is either quadrangular, hexagonal or octagonal depending upon the design of the furnance. Each furnance wall contains vertical water walls which consist of a number of close pitched parallel downcomers connected at top and bottom to common headers. The headers are interconnected by unheated downcomers. The water in the tubes of the cooling walls in this furnace rises from bottom to top in the so-called "Uprisers". Superheaters are also built in the same way, but frequently have no downcomers. A spray desuperheater is built in between the superheaters for final temperature control of the steam.

The development of the Benson boiler had been initially slow, but very steady. Upto 1934 very few boilers were in operation. The first boiler to go into operation was at Berlin-Gartenfeld in the Cable Works of Messrs. Siemens-Schuckertwerke AG, on the 1st September, 1927. By 1934, people had realised the importance of Benson boilers. Consequently, several boilers started steaming day and night. The post-war era gave special impetus to the design and it had become customary in Germany to install Benson boilers in steam power stations. Boilers having as high as 650.C final superheated steam temperature had been put into operation, and are giving trouble-free service. The maximum working pressure obtained so far from a commercial Benson boiler is 4500 psig.

ADVANTAGES OF BENSON BOILERS

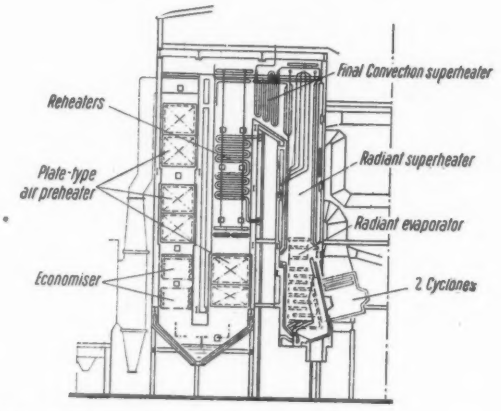
Though the basic design of natural circulation boiler has been changed to adopt many features of the Benson boiler yet the latter type has many distinct advantages :—

(1) The price of a boiler mainly depends upon design, material and labour. The first and the last may be taken to be the same in both the cases. As Benson boiler had no drums an overall saving in weight can be made upto 15 to 20% as against a natural circulation boiler.

(2) Since the total weight of the boiler is less than the natural circulation boiler and small diameter commercially standard tubes can be used, the Benson boiler shall be cheaper. This price difference in Benson boiler and equal capacity natural circulation will go on increasing with the rise of pressure from 1500 psig and upwards.

(3) Furnace walls can be more efficiently protected by adoption of small diameter close-pitched tubes as water walls in the Benson boiler.

(4) Natural circulation boilers have got expanded joints but Benson boiler has none as the pipes are welded. Hence a better response to temperature variation is achieved with Benson boilers.



High Pressure Boiler with cyclones.

Capacity	:	185 tons/hr.
Steam Pressure	:	2800 psig.
Steam temperature	:	560°C.

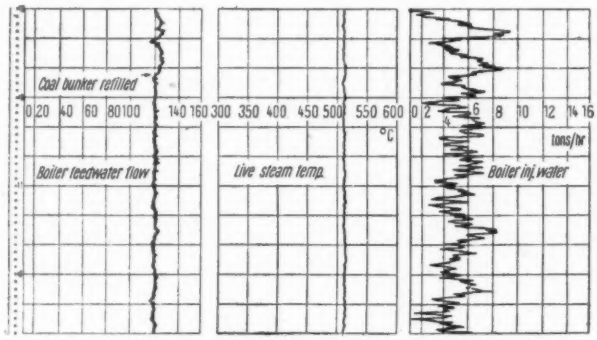

Coal bunker refilled
0 20 40 60 80 100 140 160
Boiler feedwater flow
300 350 400 450 500 550 600
°C
Live steam temp.
0 2 4 6 8 10 12 14 16
tons/hr
Boiler inj. water

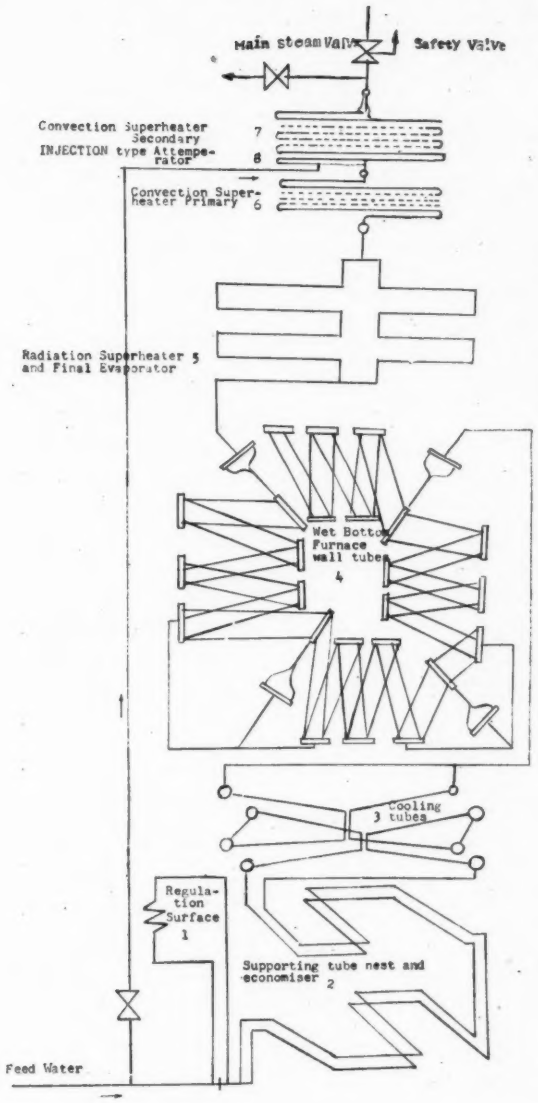
Fig. 3. Typical Benson Boiler Control Chart

(5) Because of welded joints and no special starting arrangement for the superheater, the Benson boiler can be very quickly started. The starting time may be as low as 20 to 30 minutes from the cold condition.

(6) Since the superheater is an integral part of the forced circulation system, the superheated steam temperature rises slowly. This phenomenon may be a definite advantage in unit system steam power stations, during starting of turbosets.

(7) The Benson boiler can always be operated most economically by varying temperature and pressure at partial loads and overloads. The desired temperature can also be kept constant at any pressure.

(8) Sudden fall of demand creates circulation problems due to bubble formation in the natural circulation boiler and this trouble can never be apprehended in a Benson boiler. This insensitiveness to load fluctuation makes it quite suitable for grid power stations, because the Benson boiler, though it has less water content, has better adaptive capacity to meet sudden load fluctuations.



SCHEMATIC FLOW DIAGRAM OF A BENSON BOILER

SPECIFICATIONS

Capacity	:	100 Tons/hr normal
Steam Pressure	:	2,800 psig
Steam Temperature	:	520°C.
Feed Water Temperature	:	212°C.
Economiser Surface	:	5,500 sq. ft.
Furnace Wall & Cooling Tubes	:	6,250 ,, ,,
Final Evaporator	:	1,950 ,, ,,
Superheaters	:	15,000 ,, ,,
Total heating surface including final evaporator	:	30,600 ,, ,,

(9) The blow-down losses in a Benson boiler amount to nearly 4% of those of the same capacity natural circulation boiler.

(10) The Benson boiler can be erected in a comparatively smaller floor area. The space limitation fails to control the size of Benson boiler because the basic requirements of the natural circulation boiler are not to be taken into account.

(11) The transport of a Benson boiler is easier than that of a natural circulation boiler as there are no extra heavy materials such as drums.

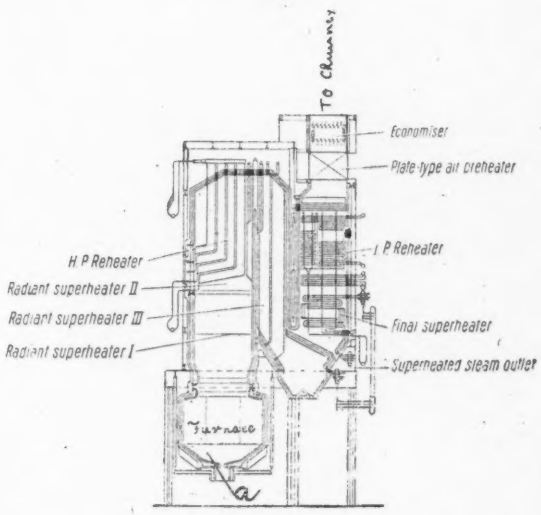
(12) The erection at site of the Benson boiler is easier and quicker. The entire parts are fabricated ready for welding in the factory. Hence the various sections are to be hoisted to the required height, fixed and welded. The laborious job of tube expansion is altogether avoided.

(13) The maximum capacity of feed pump is equal to the m. c. r. of the Benson boiler. A definite advantage over natural circulation boilers.

(14) No water gauge glasses are required. Hence maintenance becomes easier.

(15) Explosion hazards are not severe in the Benson boiler as it consits of only tubes of small diameter and has very little storage capacity in comparison to drum type boilers.

Benson Boiler

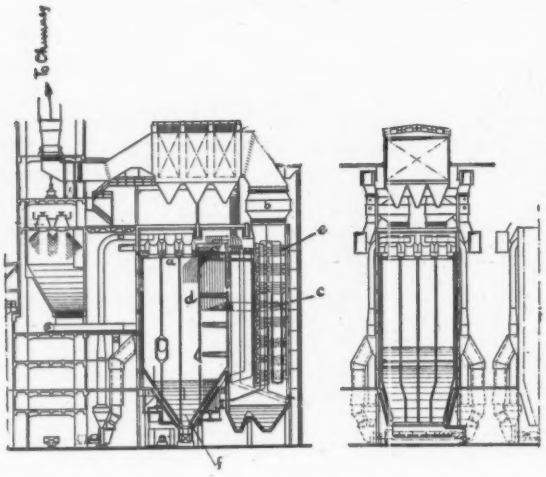


Super-critical Boiler with 2 Reheating stages :

Capacity	:	250 tons/hr.
Steam Pressure	:	3500 psig.
Steam temperature	:	610°C

(a) Wet bottom furnace.

Benson Boiler



Capacity : 450 Tons/hr.
Steam Pressure : 2500 psig
,, Temperature : 525°C

(a) Roof Burners
(b) Ljungstrom (Regenerative) Air-Heaters
(c) Reheaters
(d) Superheaters
(e) Economiser
(f) Furnace

The starting and stopping of a Benson boiler is almost similar to drum type boiler operation. First of all, the feed pump is started and then the burners are lit up. Water enters the economiser, leaves as such the superheater and is returned into the feed water circuit through the starting line 'A'. The valve 'B' is kept closed. With the gradual rise of temperature in the furnace through the superheater passes a mixture of steam and water and finally steam. Now the valve 'A' is closed and 'B' opened. The drains are kept opened and closed as in the drum type boiler. Stopping of the boiler is done by extinguishing the burners and finally stopping the feed pump.

The Benson boiler can be manually or automatically controlled just like the drum type boiler, but the former owns auxiliary heating surfaces for temperature control only as explained later.

The boiler control is effected by controlling the supply of fuel, air and feed water. As the load varies, these three quantities will also vary, accordingly, to maintain rated pressure and temperature at the superheater outlet. The drum type boilers get an impulse to control feed water from the drum water level, which is an indirect way of controlling. Should the load fall appreciably, the water level in the drum will give a false indication & hence feed water control is slightly disturbed and correct ratio of feed water and demand is not maintained, but this is not possible in case of Benson boilers. Any amount of water which is put into the boiler is converted into steam and passes out from the superheater outlet during normal operation. Hence any deviation in the predetermined value of fuel and feed water ratio, will definitely develop a change of temperature in the superheated steam. Hence Benson control can also be effected from the superheated steam temperature, but the response from this point will not be instantaneous, because of the time taken by the fluid to reach the control point. The effective control from this point may take approximately upto 8 minutes depending upon the heat storing capacity of the tubes. Now, a novel feature has been adopted in Benson boilers for this control. Just after the feed check valve, a small pipe having a small heating surface is branched off into the boiler and is connected back to the same section. This auxiliary heating surface is a by-pass to the throttle valve in the feed water main, or it is arranged in parallel to the economiser. The quantity passing through the by-pass is in direct proportion to the total feed water quantity and is normally approximately 500 kg/h. This ensures that a part of the feed water is always put into circulation in this close circuit. Any temperature variation of this water acts as an impulse for readjustment of the feed water and fuel ratio which might have been caused either due to the load variation or due to worse or better quality of fuel.

Inspite of this arrangement a constant equilibrium of the conditions in a Benson boiler cannot possibly be maintained due to fouling of the heating surfaces. That is why spray type attemperators are provided for final temperature control. The water for that spray is taken from the main feed line. The spray regulating valve is designed for a normal water quantity within 4-6% of the boiler rating and can vary depending upon the fluctuations of the super heater temperature between 0-12%. Because of the forced circulation system and the internal thermo control the response to load fluctuation is almost instantaneous. As there is no chance of priming which restricts the load fluctuations of the drum type boiler, Benson boilers can cope with any amount of fluctuations, but the overload capacity of the Benson boilers is limited by the size of the furnace. Due to the cushioning effect of steam in the boiler, water hammer in the system is non-existent. Sometimes for furnace temperature control, tilting burners are used but now-a-days, there is little use for this in Benson boilers.

The performance of Benson boilers has been found quite satisfactory. There is no chance for any type of tube section to starve. The closely pitched parallel tubes are connected by headers which ensure that irregularity of heat and internal friction losses will not affect the circulation system. The Benson boiler which has a high efficiency at the rated pressure and temperature can be operated at any intermediate pressure without sacrificing this efficiency. It can be maintained at partial and overloads by controlling the temperature and pressure combination.

There will be some salt deposits in the zone of final evaporation in the Benson boilers. Should these boilers be everyday started, it will require no cleaning because the salts deposited in the tubes are flushed out during

[*Continued on page 27*

CANADA
FINLAND
USA
INDIA
ZEALAND
FERRANTI
TRANSFORMERS
F
FERRANTI
INDIA Five 3-phase transformers, three 20 MVA, 132/33-66 kV and two 10 MVA, 132/33 kV, have been supplied for the Damodar Valley Power Scheme.
NEW ZEALAND Twenty-six 220 kV single-phase transformers have been ordered by the State Hydro-Electric Department of New Zealand. Thirteen have already been supplied.
U.S.A. Of nine 33.3 MVA, 230 kV single-phase transformers being supplied to the U.S. Army Corps of Engineers for the Garrison Dam Project, N. Dakota, three have been shipped.
CANADA Four 300 kV, 71 MVA and three 275 kV, 57 MVA transformers have been supplied to the Aluminum Company of Canada for the Alcan Project at Kemano and Kitimat.
FERRANTI TRANSFORMERS FAMOUS THROUGHOUT THE WORLD

FERRANTI LTD.

HOLLINWOOD. LANCASHIRE, ENGLAND.

Indian Distributors:

BRITISH INSULATED CALLENDER'S CABLES LIMITED,

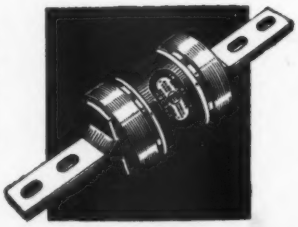
Esplanade House, Waudby Road, Fort, Bombay-1. Post Box 111

'ENGLISH ELECTRIC'

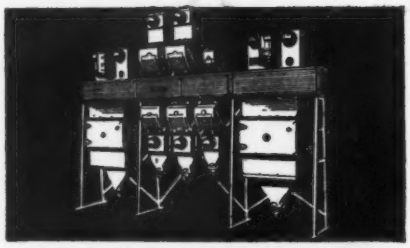
HIGH RUPTURING CAPACITY HEAVY DUTY

FUSEGEAR

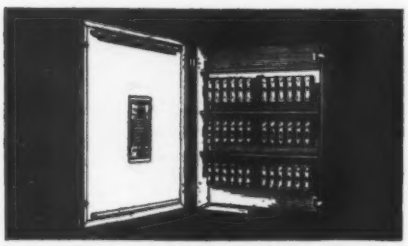
H. R. C. CARTRIDGE FUSE-LINKS
Hermetically sealed construction
Non-deteriorating
ASTA certified for 35 MVA rupturing capacity
Visible indication of operation
Ratings up to 300 amps



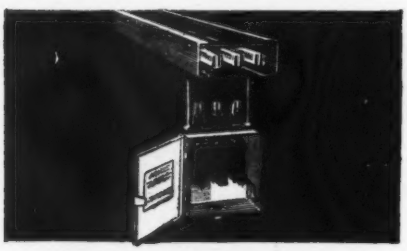
COMBINATION FUSE-SWITCHES
Ratings from 30 to 300 amps—Rugged construction, fully shrouded and interlocked—Type tested for 35 MVA rupturing capacity



COMBINATION FUSE-SWITCHBOARDS
Incorporating Combination Fuse-Switches upto 750 amps—Robust and compact construction—Readily modified and extended—Type tested for 35 MVA rupturing capacity



DISTRIBUTION FUSE-BOARDS
Robust, dust and moisture proof construction —Type tested for 35 MVA rupturing capacity —Ratings from 15 to 100 amps



OVERHEAD BUSBAR EQUIPMENT
Flexibility of power distribution—Can be installed without disturbing existing layout or production—Avoids chasing of floors for ducting—Approved by Fire Insurance Authorities

A COMPLETE RANGE OF DISTRIBUTION EQUIPMENT
MANUFACTURED AT OUR WORKS IN MADRAS

THE ENGLISH ELECTRIC COMPANY LIMITED

(Incorporated in England. Liability of Members Limited)

New Delhi Calcutta Bombay Lucknow

Agents for South India: BINNY & COMPANY (MADRAS) LTD., MADRAS

EEC-62A

Hydraulic Turbines—I

By N. VENKATA ROW

The hydraulic turbines are subject to the most varied conditions. Heads 5800 down to 2 feet and horse power from a fraction up to as much as 200,000 are in use today. The design of the turbines has to cover an infinite combinations of head, power and speed; hence it is necessary to classify them according to the types in use to day.

Hydraulic turbines fall into two groups :

Impulse: Pelton, Turgo

Reaction: Francis

Propeller: Fixed Blade, Kaplan

In impulse turbine the whole head available is converted into kinetic energy in a contracting nozzle by which the water is transformed into a free jet before acting on the runner. In its subsequent flow and throughout its action on the runner the water flows with free surfaces in the buckets and is in contact with air.

Turgo wheel is exclusively manufactured by Gilbert Gilkes and Gordon. The runner is made in one piece, with single discharge buckets held in place by the hub and outwardly by the band. The jet is directed obliquely to one side of the runner and discharged at the other side. Turgo is suitable for medium pressures and capacities. It bridges the gap between Francis and Pelton—specific speed 11.5 per jet.

In the reaction turbine the entire flow takes place in a closed conduit-scroll case—and not open to air at any point. The casing is welded to the stay ring. The integrally cast stay vanes connect the upper and lower rings and are designed to resist the bursting pressure of water in the case, to carry their part of the weight of the superimposed structure and to lead the water to the wicket gates. The wicket gates control the water, impart to it the correct whirl at the point of peak efficiency. From the gates the water enters the runner which transmits the whirl energy and the remaining pressure energy to the shaft which is directly connected to the generator above.

In the Francis turbine the runner inlet is set in level with the gates so that the water flows through the runner radially inwards and is then guided through the buckets to discharge axially. In the propeller unit the runner is set below the level of the gates and the flow through it is axial. In both the cases the water passing through the runner is lead through a sealed slowly expanding draft tube for regain of energy.

HEAD

The selection of the type of the runner for large capacity units, to a large extent, depends on the head. As an indication:

Propeller	upto 100 feet
Propeller/Francis	100 to 200 (Even up to 260 ft)
Francis	200 to 800
Francis/Impulse	800 to 1200 (Even up to 1700 ft)
Impulse	over 1200

The range of operation of the different types as Percentage of rated head:

Impulse	Minimum	90%	Maximum	110%
Francis	,,	65%	,,	125%
Propeller	,,	90%	,,	110%
Kaplan	,,	50%	,,	150%

In the case of the reaction turbines the lower limit is set by the cavitational considerations and the upper limit by the generator capacity.

The Shasta turbines are rated for 103000 hp under a head of 330 ft. The Head varies from 475 to 238 ft. Under the maximum head they can develop 187000 hp but the generator capacity being 75000 kW the turbine output was correspondingly limited. Again for the Boulder dam turbines—are rated for 115000 hp under a head of 480 ft. Under the maximum head of 590 ft they can develop 158000 hp but the output is only limited to 115000 hp to avoid the generators being overloaded.

Sometimes the range of head variation will be too wide for economic utilisation with one type of runner or one runner, without impairment of efficiency or cavitation. An interesting case is the Navia Station in Spain. There are three KMW Francis turbines each designed to develop 20, 400 hp under a head of 238 ft. and 250 r. p. m. Each turbine is supplied with an interchangable runner having different specific speed. This is required as the net head varies between 238 and 82 ft. In order to obtain the highest possible efficiency through the full range each turbine has therefore one runner for use at high heads and the other at low heads. The turbines are constructed so that the runners can be changed with an interruption in operation of less than 24 hours.

SPECIFIC SPEED

A relationship of basic importance containing a dimensionless quantity is used to classify the runner design. The horsepower (hp) developed by Q cusecs of water falling through a head of H feet is :

$$HP = \frac{QH \times 62{\cdot}5'}{550} = \frac{QH}{8{\cdot}8} \qquad (1)$$

The relation between the horsepower, head and rpm(N) is expressed by

$$N \propto \frac{H^{5/4}}{\sqrt{HP}} \qquad (2)$$

The constant of proportionality is expressed by N_s and is called the specific speed. It may be defined as the speed of a turbine developing one horsepower working under a head of one foot. In metric system the corresponding units are to be used.

$$N_s \text{ (Metric)} = N_s \text{ (British)} \times 4.45 \qquad (3)$$

The specific speed is a complete measure of the possible performance of a given runner under any head both as regards power and speed. It is an indication of the suitability of a given design for any set of given conditions. The range of specific speed for different types:

Impulse turbine	2 to 8 per jet
Francis turbine	14 to 90
Propeller turbine	over 70

The gap between 8 and 20 is partly covered by multijet impulse turbines.

Various empirical formulae have been proposed from time to time for specific speed for purposes of preliminary estimates.

For impulse turbines on the basis of some recent high head installations M/s Morgon Smith proposed:

$$N_s = \frac{200}{\sqrt{H}} \text{ Per Jet} \qquad (4)$$

For Francis turbines there are quite a few.

Moody's $$N_s = \frac{5050}{H+32} + 19 \qquad (5)$$

Morgon Smith and Bureau of Reclamation

$$N_s = \frac{632}{\sqrt{H}} \qquad (6)$$

NEMA $$N_s = \frac{650}{\sqrt{H}} \qquad (7)$$

Japanese Electro technical Commission (Metric Units) $$N_s = \frac{13000}{H+20} + 50 \qquad (8)$$

For Propeller $$N_s = \frac{7000}{H+32} + 35 \qquad (9)$$

$$N_s = \frac{316}{\sqrt[4]{H}} \qquad (10)$$

For the Kaplan turbine add 10% to the value obtained from (9). In deciding the design as high a speed as possible should be chosen, for in so doing the dimensions of the generator, turbine and hence the building costs will be reduced. However, the following points are to be taken note of:

(*a*) If the flywheel effect required is high the dimensions of the generator may be increased to a point where a costlier pole construction may have to be resorted to, resulting in a higher cost.

(*b*) By using a multijet impulse turbine or a multiple runner drive for obtaining a higher speed the cost will not be cheapened. With the multiple runners the foundation and the building costs will increase. Inlet pipes will have to be divided for each wheel and may be seperate valves are required.

(*c*) In the case of the reaction turbines low setting with respect to the tail race may be necessary. May be special material will have to used for the turbine construction.

(*d*) Higher speed means higher run-a-way speed which may result in an uneconomic generator design.

With the development of Kaplan turbines emphasis has been placed on cavitation. Investigations in this regard have shown that for a given head the speed may be selected form a wide range depending on the setting of the unit with respect to the tail race. This selection which involves widely varying costs of the generating equipment, civil works etc requires careful investigation. Estimates for alternative settings will have to be made. Particularly close evaluation is necessary in low head installations where the power house cost per kW is high.

Some projects where alternative speeds have been possible

			hP	*Head ft*	*Alternative*		*Speeds*
Periyar	Madras	Pelton	48800	1215	300	375	
,,	,,	Francis	50000	1225	600	750	
Sharavati	Mysore	Pelton	124000	1400	250	273	300
Paninar	Kerala	Francis	23000	756	600	750	
Bhakra	Punjab	Francis	150000	400	167	200	187.5

Hydroelectric installations are, so to say, tailor made jobs. It is very rare that there can be two identical installations. It is interesting to mention that in Sweden the dimensions of some of the installations are closely similar, according to KMW.

Plant	*hP*	*Type*	*Head M*	*RPM*	*D2 in mm*	*Inlets ht. mm*
Kransgede	47000	Francis	57.7	167	3000	940
Jarpstrommem	49000	Francis	61	167	3000	940
Harspranget	160000	Francis	105	167	4100	950
Kilforsen	112730	Francis	95	167	4100	
Stadsforsen	47700	Kaplan	23 to 29	125	5300	
Hojum	58500	Kaplan	33 to 25	136.3	5300	

The Cherokee and the Douglas installations of T.V. A are identical and as a matter of fact the units were interchanged.

MODELS

The design and construction of hydraulic turbines are based on the model and field tests conducted on large installations. The laws of similitude are outstanding in their accuracy and usefulness. They permit predicting the performance of any unit at any speed under any head if the performance of the homologous unit is known.

The set up for conducting the field tests is time consuming and the efficiency figures cannot be checked for the complete range of guarantee as the field conditions are out of control. Due to this, sometimes for important installations, particularly for Kaplan, technical guarantees based on models are accepted

Some notable installations where laboratory tests have been conducted:

(*a*) The 115000hp turbines for the Sungari Power house, Munchko. These at that time represented the record size. From the design considerations it was a necessity to conduct exhaustive tests.

(*b*) The 65000 hp turbines for the Aswan project. The variation in head was considerable. For the design of the inlets, for efficiency guarantees, settings exhaustive tests were made.

(*c*) The 150000 hp turbines of the Bhakra project.

(*d*) The 160000hp turbines for the Harspranget project. These were among the record installations at the time of their design.

(*e*) The 100000 hp turbines for the Genessiat project. These were also record installations at the time of their installation.

(*f*) The 17000kW Kaplan turbines for the Tonoyama project. These are among the highest head installations, for Kaplam.

The model runners have diameters ranging from 16 to 20 inches for efficiency guarantees and about half that size for cavatation tests. For calculation of the efficiency from the test results the generally recognised formulae are those of Moody's and Ackert's. The former is widely used in America whereas the latter in Europe.

Moody's $$M = 1 - (1 - M_m)\left[\frac{D_m}{D}\right]^{1/5} \quad (11)$$

Acker's

$$M = 1 - (1 - M_m)\left\{0{\cdot}5 - 0{\cdot}5\left(\frac{H_m}{H}\right)^{1/10}\left(\frac{D_m}{D}\right)^{1/5}\right\} \quad (12)$$

It is necessary beforehand to specify as to what formula will have to be used in case of model tests being asked for.

M: efficiency of full size Unit
H: Operating Head
D: diameter of full size Unit

Subceript 'm' corresponds to the model

Only in rare cases will it be possible to conduct tests in the field. Particularly with Kaplan turbines it will be more difficult. Where possible the manufacturers will avail the opportunity to check up the figures. One such case is the Bonneville manually adjustable station Kaplan turbine. The 81" diameter unit is the scale model of the main 280" units. Another instance is the Kaplan at Flix station. The variation in head is from 8 to 13 M with the discharge varying from 106200 l/s to 87200 l/s. The horse power variation is from 9400 to 13600.

RUNAWAY SPEED

If the turbine drop its load and at the same time the governor fails the unit will runaway. This is the highest speed to which the rotating parts of the hydroelectric unit are subjected to and hence to be designed for. The runaway speed will not only effect the maximum output but also the dimensions of the generator. For the different types:

Pelton wheel	1.8 to 1.9 times the normal speed:	
Francis turbine	2.0 to 2.2	,,
Kaplan turbine	2.5 to 2.8	,,

The runaway speed not only depends on the normal speed but may be increased further when the head

is subject to variation, as this speed will have to be determined for the maximum head. In the case of Kaplan Turbine the speed may go up as much as 3.5 times the normal speed under the highest head with the runner and guide vane controls failing and the guide and impeller blades locked in the most unfavourable position. The probability of such a situation arising is very remote. This maximum figure tends to decrease with the blade pitch increase and with full tilt most Kaplans would not attain 100% overspeed. In the case of the Blondel turbines the variation in head is 16 to 25 meters, the racing speed would have been 280 compared to the normal speed of 107.2. With the runner emergency regulation adopted, by which the blades are closed on a given speed being exceeded, the overspeed has been reduced to 130. In the case of the Aswan Kaplans an unusual figure of 3.2 times the normal speed has been taken for the design as the variation in the head was too wide—7 to 31.2 meters.

ARRANGEMENT

Horizontal and vertical arrangements of the generators are encountered in general practice.

Vertical arrangement gives better efficiencies due to reduced losses. The whole weight of the rotating parts is taken by the thrust bearings, which with modern designs give very little losses.

In the horizontal arrangement the weight is borne by two or more journal bearings, which have higher losses. In addition in the horizontal arrangement a bend in the draft tube is necessary. This means the water passes in the bend at full discharge velocity. This involves greater losses.

Vertical arrangement affords better protection against risk of damage to the generator due to flooding.

To guard against damages due to the cavitation the horizontal arrangement warrants the setting of the floor of the station below the tail water level. This entails greater excavation.

Vertical arrangement lends itself more conveniently to arrangement of closed circuit cooling for the generator.

Some of the disadvantages of the vertical arrangement are: In this arrangement

—cannot use more than one runner
—accessibility for maintenance is not as good as in the horizontal arrangement
—a more complicated sub-structure is necessary
—erection is a difficult problem. The schedule is to be well laid out in advance to avoid holdups.

In the reaction turbines the advantages outweigh and horizontal arrangement is rarely used. For impulse both types are encountered. In the horizontal there can be.

—single runner with single nozzle as in Pykara or Pallivasal.
—two runeers, driving the same generator, each with one nozzle as in Dixence or two nozzles as in Jog. The runners may be mounted on the same side as in Sengulam or on either side of the generator-Jog.

The ease with which the water can be expelled from the buckets in a vertical arrangement, without the jets interferring with each other enables more than two nozzles being used. There are installations with 2,3,4,5,6 nozzles, eg., Moyar, Kundah II, Kitimat, Kundah I and Bridge River respectively.

For the sake of convenience, etc., generally all the units will be placed in one line. A rather unconventional design has been adopted in the case of L'Aigle (France). The turbines were placed in a semicircle and the inlet pipes were arranged radially. The station has been built in a narrow glen and therefore the dam outlets have been formed as shoots looking like ski-jumping slopes above the roof of the power house.

The above remarks apply whether it be for indoor or outdoor or underground installation. There is no outdoor impulse installation.

For an outdoor installation the relation between the flood level and the generator floor level is sometimes the deciding factor. A large number of units favour this type of installation. For stations with only one or two units the outdoor crane works costlier than the superstructure.

There is a trend for underground installation of the generators and turbines as well as transformers with associated switchgear. The layout doesn't deviate much from the stations aboveground. Underground location gives some advantages:

(*a*) Safety against bombing, rock and earth slips.
(*b*) allow higher operation heads
(*c*) Do not disfigure the scenic beauty
(*d*) as excavation can be in hard rock, the draft tube, penstock and surge shaft can be cut in it. Considerable savings in the power house costs are possible.

These stations are common in Norway, Sweden, Italy, Switzerland, and France. As a matter of fact in Norway an ordinance has been passed insisting that all stations of capacity over 20MVA are to be underground type. In general underground stations can be classified:

(*a*) The tail race can be a free level tunnel without a surge shaft as in Innertkirchen, Bersimis

(*b*) The tail race can be a pressure tunnel with a surge shaft upstream as in Harspranget
(*c*) There may be surge tank on either side.

PENSTOCKS

The pipe connecting the forebay and the scroll case is called the penstock pipe. The diameter of the pipe

is to be decided after taking into consideration various alternatives with regard to the cost, turbine regulation, diameter required at the entrance of the scroll case, and the mechanical strength for carrying the water.

Velocity of water in the penstock will have an influence on the turbine regulation. Higher velocity leads to unfavourable regulation. Emperical formulae for determining the velocity and the diameter of the pipe have been proposed by Beir of Bureau of Reclamation:

$$V = 0.125\sqrt{2gH} \qquad (13)$$

$$D = \left[\frac{P}{H}\right]^{0.466} \qquad (14)$$

Advantages claimed are:

1. Thorough visual inspection of plates after rolling
2. Certainty that the ultimate shell strength will approach that of the steel plate.
3. Negligible residual welding stresses after welding, which makes stress relieving unnecessary.
4. Less susceptibility to brittle fracture.

The first multi-layer penstock was built for the Rio de Janerio tramway Light and Power Company in 1945. The maximum static head was 1112 ft. and the turbine was rated for 53,400 hp. There was saving in steel to the extent of 10.4%. Three penstocks were supplied to the Sao Paulo Light and Power Company each to feed a 91,800 hp impulse turbine under a head of 2200 ft. The saving effected per penstock in steel was 11.2%.

Plant	*Head ft*	*hp*	*Curecs*	*Actual values*		*From* 13		*From* 14	
			Q	*ft/set*	*D ft*	*V*	*D*	*V*	*D*
Hoover	380	115000	2450	18.5	13	22	11.9	18.9	12.8
Grand coulee	330	150000	4500	17.7	18	18.2	17.7	19.1	17.3
Hungry Horse	400	105000	2542	17.8	13.5	20	12.7	18	13.4
Shasta	330	103000	2800	15.8	15	18.2	14	16.9	14.5

The formula for determining the pipe thickness:

$$t = \frac{PD}{2+e} \qquad (15)$$

where t thickness at point X

P pressure inclusive of water hammer
F allowable stress (16000 lbs/sq inch)
e efficiency of the joint
D diameter

About 1/16″ is to be added for corrosion. The minimum thickness is 1/2″. Since the head varies along the profile of the penstock it may be economical to use thicker plates near the inlet to the tubine and thin plates nearer to the forebay.

Messrs. A. O. Smith have developed methods in penstock construction. This is on the basis of multi-layer principle they have developed. As the name implies the multi-layer construction involves the use of several layers of steel, each progressively warped and tightened around a cylinder by mechanical means and then welded together at the edges. The thickness of the inner shell is from 3/8″ to ½″ and the outer shells are approximately 1/4″ in thickness. Multi-layer construction begins with a total wall thickness of 5/8″. This multi-layer construction has been extended to the design of Wyes, distribution lines.

If the ratio of the length of the penstock to the head is not more than 3 or 4, satisfactory governing can be obtained. If it exceeds, special precautions are to be taken.

The penstock factor is a measure of the inertia of the water column in the penstock as compared with the regulating constant of the machine. Hydraulic inertia is defined by

$$\Theta = \frac{LV}{gH}$$

L length of the pressure conduit
V velocity of flow
H head

The value of Θ is normally between 0.5 and 3. In good design

$\frac{LV}{H}$ should not be greater than $\frac{WR^2 \times N^2}{HP} \times 10^5$

wr^2 is the inertia of the rotaing masses
N speed in rpm
HP Horse Power of the turbine

Water hammer pressure rise consequent to the Closure of the turbine gates or the nozzle, as the case may be—is of importance in the design of the penstocks. Allowance of 10% of the static head is taken by the Pacific Gas and Electric Company as in their experience this is adequate. For penstocks embedded in concrete or in the dam, pressure rise of 30% can be taken and, in certain Europeon installations, even 50% was allowed.

(To be Continued)

TOUGHEST

BELTS IN THE WORLD

TELL US
YOUR JOB—
GOODYEAR
HAS THE
RIGHT BELT
FOR YOU!

Put an end to belt worries!

GOODYEAR

PSIP 13A

THE GREATEST NAME IN RUBBER

Soil Investigation in Relation to Foundation of Hydraulic Structures

By PRIYATOSH RAY

Foundation is defined as that part of a structure which transmits its own weight, the weight of the super structure above it and any force acting upon it to the material on which it rests. So practically foundation is the connecting link between the super structure and the soil. Its function is to support and distribute the overburden load to soil layers beneath in such a manner that the underlying material is not stressed beyond its supporting capacity which takes into account safe bearing power and permissible settlement. Excessive stresses may cause a complete rupture within the soil mass and a considerable tilting and sinking of the structure as a whole.

The design of a foundation is governed by two main considerations.

(1) The soil must be safe against failure by shear,
(2) The structure must be safe against excessive settlement due to consolidation of the soil under the foundation.

For civil engineering structure it is important to have the soil tests done and the shearing value established for the soilin each stratum present below the foundation. From these test results ultimate bearing capacity and safe bearing capacity are calculated. In fact, complete failure may occur if the ultimate bearing capacity of the soil is exceeded.

The strain that is produced in the soil by the overburden stress, when it goes beyond some limit, may give rise to uneven and undue settlement of the supporting soil mass thereby developing cracks, fractures and deformation of the structure. Magnitude of strain will depend on the intensity of the overall load of the structure that will be imparted to the underlying material. Distribution of the normal vertical stress is needed for the solution of settlement problems. So, a knowledge of the stress-strain characteristics and, at the same time, drainage characteristics of the foundation soil is essential before any construction is taken up.

The modern engineer engaged in foundation work has thus great need for a thorough understanding of the soils as structural materials. He will need the ability to obtain and evaluate evidence upon which he has to predict the probable action of soils in innumerable varieties of arrangement and properties. Soil properties vary considerably because of different compaction, moisture content and physical make-up. The soils may be mixtures possessing to some extent the various characteristics of their constituents or have been assembled in an infinite number of combinations and stratifications. Planning of the superstructure is based upon the characteristics of the foundation material, and to use the existing soils in a given site it may be necessary to devise ways to improve the situation in the interest of economy. Determination of the type of foundation in a specific case, comparison of cost, suitability, ease of construction and safety also depend on the nature of the soil at the actual site. Further, planning and making vital decision are faced with problems beset with uncertainties. Nature has erected most of these deposits in an erratic manner and placed them as they are. The characteristics and probable actions of these materials under load may be difficult to ascertain. Floods may wash away the soil or inundate the structure or may exert pressures of unknown magnitude, or a soil material of slushy nature or a questionable fill may lie buried beneath mud and sand. These are positively detrimental to founding a structure. So in any case a clear and thorough knowledge of the soil is absolutely necessary before planning, designing and building a structure.

CHARACTERISTICS OF FOUNDATION MATERIALS

In general, rock, gravel and sand are considered to be the best foundation materials. But it is not wise to remain contented if these materials only are found to occur in the foundations.

As regards rock, it is important to ascertain the kind of rock, the presence of any cracks, the dip of strata and the alope of the surface. Shattered or broken rocks are unreliable for heavy loads. Sometimes grouting is effected to fill up the cracks but if the cracks are filled with clay and silt, efficiency of grouting may be doubtful. Lime stone as a foundation for a dam may fail because of hydration along leaking cracks.

Boulders, especially large and irregular ones, are not trustworthy because of the weaker underlying and surrounding materials and because of their tendency to tip. Besides boulders deep down under plastic weak soils may cause serious difficulties in driving piles.

Gravel, except shally gravel, is an excellent foundation material. It has very little capillarity. But it should not be underlain by a weak stratum.

Sand is ordinarily a good foundation material. But when it is fine its strength and angle of internal friction decreases. When it is very fine and saturated it may become quick and flow out under even small hydrostatic pressure if any how it finds some way for escape. Sites in which quick sand exists should be viewed with great suspicion and special care and

attention should be paid to tackle this difficult problem. Thorough tapping with tied sheet piles may serve as a remedial measure.

Silt is one of the most unreliable material for foundation. It possesses high capillarity, non-plasticity and has low strength and frictional resistance. The most deceiving factor in case of silt and fine sand is the part played by porewater pressure. During excavation the ground water that leaks in, may carry enough silt with it thereby causing undermining and settlement to adjacent areas. Silt and fine sand are likely to be blown up in the bottom of an excavation if a hydrostatic head exists below the bottom. Further, silt once badly disturbed will have a very low supporting value for long time or it may show movement from under a hydraulic structure even at a small difference of water head. Unfortunately silt occurs extensively in the alluvial regions specially near the river sites. This material is likely to be encountered in most of the cases of construction of hydraulic structures. The presence of silt deposits in the construction site requires active attention of the design and construction engineers.

Clay usually contains and effectively retains considerable moisture. In moist state clay is highly plastic and compressible. It may even flow slowly under long continued pressure. So moisture content of clay is an important factor in respect of strength and consolidation. It changes in consistency also with change in moisture content. Impermeability of clay is an advantage during excavation.

Peat soil or soil with high percentage of decomposed vegetation may be worthless as foundation material and should not be trusted underneath important structures. It is very slippery when wet and may flow out under pressure if it finds way for escape causing settlement and hence damage to a structure. In West Bengal there are areas where considerable deposits of peat soil exist. Fortunately these unsatisfactory deposits are localised and not very extensive.

IMPORTANCE OF SOIL INVESTIGATION

The above account will show that a thorough and detailed soil investigation is absolutely necessary for the foundation of a structure before planning designing and construction. Soil investigation may broadly be divideed into two items—(1) Field exploration and (2) Laboratory study.

Both are complementary and essential to ascertain the nature of the soil as it exists. The type of soil, the class to which it belongs so far as the size distributions of particles are concerned in-situ dry density, moisture content, void ratio, bearing capacity, consistency, consolidation under load, permeability and depth of each stratum are to be studied closely. From these studies and investigations an idea about the soil profile may be obtained. On the basis of these investigations, decisions about the future programme of work will have to be made.

(a) Field Investigation

One of the prerequisites for selection of a suitable site for any hydraulic structure is the collection of informations about the soil formation of the particular site. Geological logging of the soil is to be obtained. District Gazetteer may throw some light in the matter. Old persons of the nearby localities may also tell from their memory if there was any forest, any river course, any canal or any ditch in the site. Sometimes opinions of aged people have been found to be assets of inestimable value. If satisfactory informations are obtained from these sources, scientific exploration work may be taken in hand.

The most modern practice for this purpose is to use boring and sounding equipment. For a preliminary and quick survey of the area, soil is sounded for penetration resistance and bearing capacity of in-situ soil at every foot or every half a foot up to a depth depending on the nature and magnitude of the proposed projects. This depth is generally taken to be about 100 ft. The principle of sounding may briefly be stated as follows: A cone is driven vertically into the ground at a regular and constant rate and the resistance offered by the soil is read directly in a pressure gauge. From these readings the bearing capacity of soil at any desired depth is calculated. From these values of sounding an idea about the nature and condition of the sub-soil can be formed. If there is any indication of the presence of any bad soil or soft clay all through, the idea of selection of the particular site may have to be abandoned or special measures will be required as a remedy. Otherwise in order to obtain a clear knowledge about the subsoil, boring is necessary for taking samples in the undisturbed condition. Soil sounding is to be taken at close intervals of space in the preliminary survey. It may be 50 to 100 ft. apart in the actual site of construction. From the chart showing the sounding values and values for bearing capacity the soil profile may be read and if the same appears to be erratic samples are to be collected from questionable strata, and the nature and properties of the soil studied in the laboratory. Of course it is not difficult to take undisturbed samples of small size by the sampler of the sounding apparatus from every foot of depth. A visual examination of the soil is possible with these samples from which a log of boring may be prepared for ready reference and comparison. It is to be carefully seen that no dangerous material underlies any hard stratum. If any hard stratum is encountered its depth must be determined. Load tests may be done in the field to get an idea about shear strength and settlement.

(b) Sampling and Laboratory Tests

For detailed study of the different engineering properties of the foundation soil, undisturbed smaples, preferably 4 inches in diameter and 1 foot long cylindrical samples, should be collected by boring process and sent to the laboratory. Collection of such samples may be done from every 5 feet interval of depth. Of course, there is no hard and fast rule about it. It is based on convention rather than rational considerations. The only thing that is to be taken care of is

that the samples should be representative of different soil strata. It is advisable to select the soil layers for sample collection in close co-operation with the field and laboratory people alike as both parties have something to contribute to this end. The size of the sample is recommended as above because of the fact that it should be sufficient for extracting out of it the required number of test specimens, which are necessary for carrying out the important tests in the undisturbed state. The sample tubes, with samples in, should be properly sealed with wax so that there is no loss in moisture during transhipment to the laboratory. The number and depth of borings will vary with the type and nature of the proposed structure. Boring some 200 ft. apart is done. But at least three borings normally should be done on the central line of the proposed structure, one at the central point and the other two on the two wings. Elevation of ground water should be noted as it is also an important factor.

As to laboratory tests and experiments, though these may not tell everything and answer all questions, these can definitely help the foundation engineer in many respects. So it is necessary for him to get all possible informations from the tests. The following tests are generally carried out on the undisturbed samples collected by boring from different depths (1) triaxial shear (2) unconfined compression, (3) consolidation, (4) void ratio, (5) natural density and (6) permeability. Other necessary tests include determination of (1) particles size distribution, (2) natural moisture content, (3) specific gravity, (4) Atterberg limits, (5) shrinkage and (6) capillary rise. D85 and D15 sizes of sands of different grades are also determined when inverted filter is used to prevent movement of soil due to hydrostatic and seepage forces. From the triaxial shear and unconfined compression tests, the shear strength, angle of internal friction and cohesion are obtained. From the consolidation and void ratio tests the amount and rate of settlement and time required for 50% and 90% of the primary consolidation can be determined. Distribution of vertical stress can also be computed from these test data. Permeability test can say whether it is likely for the seepage force under the hydraulic gradients developed at different flood stages would carry soil particles with it. Movement of soil materials helps to the formation of piping which ultimately can cause damage to the structure. Before designing, the exit gradient is calculated from laboratory test results.

As the collection of perfectly undisturbed soil samples from depth is usually a difficult process, attempts are being made to find out relations if any, between the properties in undisturbed and remoulded soils. A number of such relations have been obtained, but they are to be tested on a wide variety of soils before any generalisation can be made. Thus in the event that samples could not be collected in perfectly undisturbed state, their different engineering properties may be studied by testing remoulded soil samples compacted to the same density and at the same mositure content. However, it is not very difficult to conduct tests on any soil and get correct experimental values for each test, but it is really very difficult to interpret these data and apply them in the field. This is because laboratory tests may not always give very accurate data in case of undisturbed samples due to the fact that any slight disturbance or swelling during and after sampling may strongly affect the numerical values for the soil constants.

In addition to these physical tests, a soil is required to be tested chemically in order to detect the presence of any salt which may in the long run cause deterioration of concrete used in the construction. A soil highly alkaline and containing sufficient quantity of sulphates brings about deterioration of ordinary concerete. In general soil containing more than 0.1% of sulphates is likely to attack concrete.

CONCLUSION

Thus it will appear that a systematic study of the foundation soils is essential to ascertain their nature, characters and behaviour under stress of each particular problem. Based on these investigations and studies decisions regarding the type of foundation that will be suitable for the selected site and for the desired purpose may be taken and designs made accordingly. But at the time of actual construction, when excavation is carried out, it is not unlikely that unfortunate, unexpected and dangerous conditions would be discovered due to diverse and complicated soil characters. It is wiser to watch the situation carefully and overcome the same immediately than to stick to the preconcieved plans just to avoid expense and embarrassment of revising the design. In fine, attention is to be drawn to the fact that all foundation soil investigations are badly in need of a scientific approach and co-operation between the foundation engineers and the soil scientists working in the laboratory.

REFERENCES

(1) Structural foundations—By R. R. Minikin.

(2) Foundations of Structures—By C. W. Dunham.

(3) Practical Problems in Soil Mechanics—By H.R. Reynolds & P. Protopapadakis.

(4) Soil Mechanics in Engineering Practice—By K. Terzaghi & R. B. Peck.

(5) Pile Foundations—By R. D. Chellis.

(6) Soil Mechanics, Foundations & Earth Structures—By Tschebotarioff.

Indus Waters Treaty

The negotiations for the conclusion of a Water Treaty between India and Pakistan in settlement of the Indus Waters question are continuing in Washington under the auspices of the World Bank. It is hoped that final agreement on all the outstanding points to be included in the Treaty will be reached within the next two months.

The Treaty would be based on a division of the Indus Waters on the lines of the Proposal made by the Bank to the two Governments in February 1954. Under this Proposal the three Eastern Rivers of the Indus system (Sutlej, Beas and Ravi) would be for the use of India, and the three Western Rivers (Indus, Jhelum and Chenab) would be for the use of Pakistan.

This division of the waters necessitates the construction of works to transfar, from the three Western Rivers, supplies to meet the irrigation uses in those areas of Pakistan which have hitherto depended on supplies from the three Eastern Rivers. The effect of this transfer would be to release the whole flow of the three Eastern Rivers for irrigation development in India, and, as part of the Treaty, India would agree to contribute towards the costs of these works. The system of works to be constructed would, however, provide further substantial additional irrigation development both in India and Pakistan and, as well as irrigation, would develop important hydroelectric potential in both countries. It would also make an important contribution to soil reclamation and drainage in Pakistan, and provide a measure of flood protection in both countries.

It is estimated that the total cost of the system of works to achieve these results would be of the order of the equivalent of $1,000 million, partly in foreign exchange and partly in local currencies.

The Bank has evolved a plan to finance the required expenditure and has had assurances from certain friendly governments of their readiness to participate in the cost of the Plan, over and above the amounts to be contributed by India and Pakistan and by the Bank itself. The implementation of the financial plan, and the participation of the governments concerned would, of course, be contingent on the ratification of the Water Treaty now under negotiation and would be subject to such parliamentary and Congressional action as may in each case be necessary. The participation of each of the friendly governments concerned would be as follows :

A. In Foreign Exchange

Australia	A	6,964,286	in grants
Canada	Can.	22,100,000	in grants
Germany	DM	126,000,000	in grants
New Zealand	NZ	1,000,000	in grants
United Kingdom		20,860,000	in grants
United States	U.S.	177,000,000	in grants, and
	U.S.	103,000,000	in loans

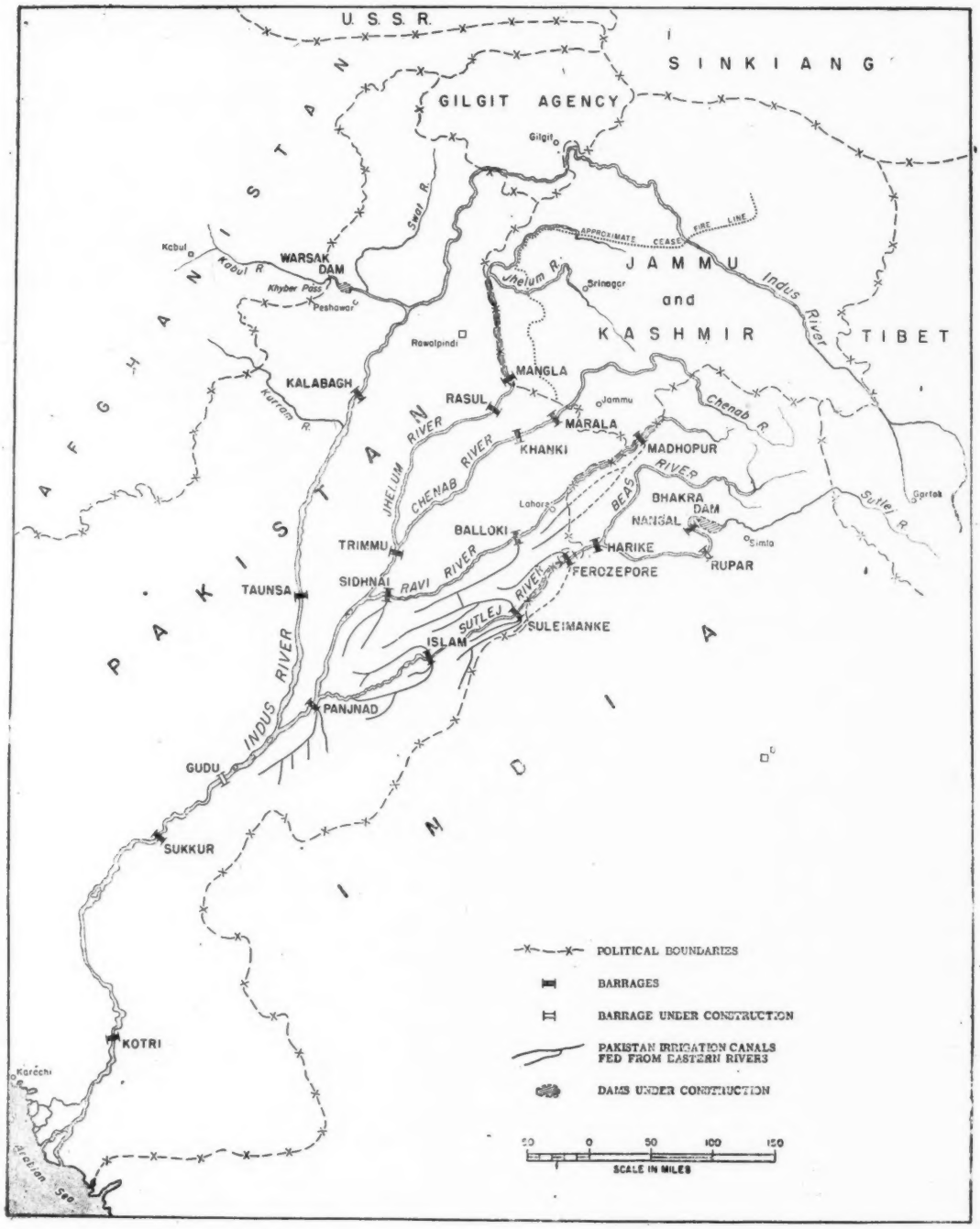
B. In Local Currency

United States The equivalent of U.S. $235,000,000

The President of the World Bank is prepared to recommend to the Bank's Directors that the Bank should participate with loans to India and Pakistan of the order of $103 million.

The Bank's financial plan envisages that all construction contracts would be open to competitive bidding, and that the foreign exchange contributions would be freely useable for purchases anywhere in accordance with procedures similar to those followed by the Bank in its normal operations.

The costs of the construction programme would be spread over a period of approximately ten years, and the general supervision of the programme would be undertaken by the Bank.


U.S.S.R.
SINKIANG
GILGIT AGENCY
Gilgit
AFGHANISTAN
Swat R.
APPROXIMATE CEASE FIRE LINE
Kabul
Kabul R.
WARSAK DAM
Khyber Pass
Peshawar
Jhelum R.
Srinagar
JAMMU and KASHMIR
Indus River
TIBET
Rawalpindi
KALABAGH
MANGLA
Kurram R.
RASUL
Jammu
Chenab R.
MARALA
JHELUM RIVER
CHENAB RIVER
KHANKI
MADHOPUR
BEAS RIVER
BHAKRA DAM
NANGAL
Lahore
Simla
Sutlej R.
Gartok
BALLOKI
TRIMMU
HARIKE
RUPAR
RAVI RIVER
SIDHNAI
FEROZEPORE
TAUNSA
SUTLEJ RIVER
SULEIMANKE
ISLAM
PAKISTAN
INDIA
INDUS RIVER
PANJNAD
GUDU
SUKKUR
KOTRI
Karachi
Arabian Sea
POLITICAL BOUNDARIES
BARRAGES
BARRAGE UNDER CONSTRUCTION
PAKISTAN IRRIGATION CANALS FED FROM EASTERN RIVERS
DAMS UNDER CONSTRUCTION
50 0 50 100 150
SCALE IN MILES

A Notable Convention on Irrigation

The American Society of Civil Engineers at its Annual Convention devoted some sessions to a consideration of irrigation and other civil engineering problems in foreign countries sometime in October 1959. Over 30 papers were presented and some of the leading engineers participated. We give below a brief report of some of the papers discussed at the convention.—Editor

IRRIGATION WILL PLAY BIG PART IN SOLVING INDIA'S FOOD PROBLEM

Irrigation will play a leading part in the long-run development of India, whatever the path or combination of paths leading to immediate increased food production, Prof. Ingersoll asserted at the convention.

Alfred C. Ingersoll, Associate Professor of Civil Engineering at California Institute of Technology, Pasadena, referred to India's potential food crisis, which he said "dwarfs all famines in her history," in the presentation of a paper on irrigation progress and problems in the Asiatic nation.

Prof. Ingersoll reported on an ironic twist in India's problems. He said that India leads the world in irrigation practice and technique, with approximately 58 million acres under irrigation annually, second only to China in quantity of irrigated acreage.

Yet, "her glorious past notwithstanding," India's present food crisis is "a tragic example of the lesson that *vast irrigated acreage, by and of itself, cannot solve the food problems of a rapidly growing nation,*" the educator declared.

"In the first part of the past decade, in fact, it was necessary for India to import food grains to the extent of approximately $200 million per year, thus spending as much for food imports in one year as was actually expended on the construction of irrigation works over the 100-year period ended in 1947."

Prof. Ingersoll noted that although India does, in good years, approach self-sufficiency in food, *the rate of population increase is outstripping all advances in agricultural production.*

He referred to a recent report of the Ford Foundation Agricultural Production Team, which said that India's *rate of food production must be tripled,* and that the rather low productivity of the land already under irrigation must be increased by better land management and water use.

The California professor also slapped his audience gently by saying that India's irrigation development and problems "deserve a better hearing among American civil engineers."

"Among all the countries participating with the United States in the projects of the International Cooperation Administration, India has by far the most extensive program, and a great part of it relates to agriculture and civil engineering works," he stated.

Despite this, he added, the most recent paper on India's irrigation development appeared in a publication of the Society 70 years ago.

"At that time," he said, "American engineers stood awe of the advanced development represented by India's irrigation works. This was especially accentuated by the haphazard planning which marked early irrigation development in western United States of the time.

"*India remains today the worlds' leading country in the science and techniques of irrigation engineering,* and certainly the one with the best recorded history for the edification of the civil engineer in the western world. Despite the rapid development of the past 70 years in the United States, American engineers still have much to gain by Indian experiences."

ENGINEERING COULD SOLVE FOOD PROBLEMS IN CEYLON

Members of the American Society of Civil Engineers got a graphic illustration of why they are needed throughout the world.

As an example, the civil engineering problems of Ceylon, an island in the Indian Ocean off the coast of India, were presented to the convention by Philip P. Dickinson, technical assistant to Senator Clair Engle, (D. Calif.).

In Ceylon, rainfall varies from a maximum of 228 inches a year to a minimum of 36 inches. Yet, said Mr. Dickinson, a civil engineer himself, Ceylon has to have irrigation to produce food for its growing population. Even now, he said, *Ceylon has to import about half of its food to keep the nation alive.*

Compared to Ceylon, rainfall in the United States ranges from 80 inches on the Olympic Peninsula, in the state of Washington, to a fraction of an inch in the state of Arizona. In the United States however, food supplies are adequate, and there are surpluses, such as in the case of wheat storage.

One reason why Ceylon has to resort to irrigation, despite its heavy rainfall, is the mal-distribution of rainfall, both seasonally and geographically. All of

Ceylon is hot and humid, he said, andthe three-equarters of the island called the "dry zone" is really dry only in comparison to the "wet zone."

"The other reason is rice," Mr. Dickinson stated. "Although Ceylon's three principal cash crops are tea, rubber and coconuts—all grown without irrigation—its daily diet is rice. And rice is grown only under irrigation, even during the monsoons."

"The flooded paddy fields, usually in small plots, dominate most cleared flat lands and many high terraces, some of which are narrowly cut along amazing slopes.

"Rice culture requires a controlled water supply—an abnormal duty on Ceylon—up to 130 inches per crop, including rainfall."

By way of comparison, he said, water requirements for rice culture in Louisiana is 20 to 36 inches, in California 36 to 96 inches, and 48 to 72 inches in Japan.

While irrigation has been practiced in Ceylon for over 2,000 years, there is still much to be done to make Ceylon self-supporting, which is where the skills of the civil engineers will be put to good use.

An American advisory team of technical assistants is now in Ceylon under the International Cooperation Administration to help the government plan for solutions of its food problem. One solution may be in the development of more hydroelectric facilities, to *provide electric power for better irrigation and drainage in the food producing areas.*

IRRIGATED AGRICULTURE SEEN AS IRAQ'S SALVATION

Iraq's future depends on irrigated agriculture, rather than political inclinations, an American civil engineer Mr M. R. Lewis told the convention.

The speaker, M. R. Lewis, of the engineering firm of Carroll E. Bradbury and Associates, Los Altos, Calif., was one of several engineers who reported to the American engineering organization on world wide irrigation progress and development, and its influence on economic problems.

Mr. Lewis said that Iraq, as an historical entity, and irrigation appeared together some 6,000 years ago in Mesopotamia, the valley of the Twin Rivers. "Ever since, they have risen and declined together," Mr. Lewis declared. "*Perhaps nowhere else in the world has civilization been so closely tied to man's control of water.*

"Except for the newcomer, petroleum, irrigation agriculture has been almost the sole support of Iraq, first as a direct source of subsistence and, second, as the source of trade-goods and exports.

"The emphasis devoted to irrigation and drainage by the Iraqi Development Board in recent years indicates the realization by the government that its well being and that of the people is unequivocally dependent on irrigated agriculture.

"Indeed," the engineer added, "throughout history the essential heritage of the people of Iraq is and has been irrigation.

"It is hoped that neither inside or outside subversive influences will overshadow its importance."

Mr. Lewis discussed *war, floods, excess salts, sedimentation and changing trade routes as causes of the decline or abandonment of the great irrigation systems* of Iraq. He said that notwithstanding its great wealth in oil, irrigation is the esential heritage of Iraq.

PEACE NEEDED TO DEVELOP IRAQ'S IRRIGATION PLANS

The irrigation potentials of the Tigris and Euphrates river valleys, site of the great flood of biblical times, were studied at the convention.

Making a report on the irrigation system of the Tigris and Euphrates in ancient and modern times, Stanley S. Butler, of Los Angeles, said that successful development of irrigation in the valley of "Noah's Ark" depended a great deal on "*a condition of peace and cooperation with neighbouring countries.*"

Tracing the history of the valleys of the rivers, Mr. Butler, associate professor of civil engineering at the University of Southern California, said that the land is potentially fertile and productive, as it was thousands of years ago.

"There is another matter that also has not changed since ancient times, and that is the *necessity for good planning and administration*," Mr. Butler stated.

"Now, as then, successful development of irrigation in the valley of the Tigris and Euphrates is greatly dependent on good engineering, progressive laws, efficient administration, and a condition of peace and cooperation with neighbouring countries."

He said that *if neighbouring countries will allow dams and reservoirs* to be built in the upper reaches of the rivers, and if Iraq can plan on the basis of sole user of the irrigation water supply from the two rivers upstream from the Shatt-al-Arab, it will be economically feasibile to develop an irrigation water supply from the two rivers to irrigate about one and one-half times the presently irrigated area.

Also, it would be possible to irrigate most of it at about two to three times the present intensity of irrigation, by having *more crops per year*, and by *rotating crops* instead of allowing half of the land to lie fallow, as at present.

But note that these determinations assume two things : (1) that Iraq's neighbours will cooperate in the building and operations of dams and reservoirs

in the upper parts of the rivers and their tributaries, and (2) that no other country will extract, for consumptive, use, any appreciable portion of the river water."

The engineer said there are a number of reasonable good dam sites on the two rivers and their tributaries in Iraq, and added it may be possible to build some dams in the upper reaches in Turkey, where both rivers originate.

The Iraqis of today, he noted, have a population which is basically strong, intelligent and ambitious, a great amount of land of undeveloped potential for irrigation, and a supply of money from oil to finance the work.

"As is true in many other parts of the world, including the United States, the biggest problem in Iraq today is to gain public support for doing water to the irrigation engineer obviously should be done, especially the consideration of long-range benefit in addition to immediate benefit, through such things as developing a strong, well-paid staff of engineers, providing for adequate agricultural drainage, guarding against overdevelopment of ground-water basins, and the establishing and maintaining of a strong program of collecting basic agricultural and hydrologic data for the most efficient planning and operation of the work," he said in conclusion.

30 FOREIGN COUNTRIES AIDED BY U.S. RECLAMATION BUREAU

How the U.S. Bureau of Reclamation has expanded its activities to include technical assistance on water resources to 30 countries of the world was told at the convention session.

The principal business tof the Bureau for the past 57 years has been the development of water resources of the 17 western states of the United States, Alfred R. Golze, Assistant Commissioner of the Bureau, Washington, noted for the record.

But with the passage of certain laws by Congress in recent years, the Bureau has found itself in the business of providing technical assistance to foreign countries, chiefly in the form of training foreign nationals at its various field installations, providing specialized short-term technical assistance and directing long-term engineering and economic investigations on assignment, Mr. Golze revealed.

"In total, the Bureau has sent overseas over 100 technical groups or missions including more than 300 Bureau of Reclamation personnel to some 30 different countries, all at the express request of the countries involved," he noted.

"These assignments dealt directly with water resource development and were arranged by intermediary organizations such as the United Nations or the International Cooperation Administration."

Mr. Golze also revealed that since 1949, the Bureau has registered 1,060 engineers, economists and others from 49 countries for training at the Bureau's offices and projects in this country.

Financing of these activities with foreign countries is independent, he said, of the domestic approporiation of the Bureau of Reclamation, with arrangements that vary with the different countries.

"Indeed, many of the foreign countries finance part of the training or technical assistance programs with their own funds."

As an example, he cited the Ethiopian Blue Nile Investigations program as having been financed more than 50% by Ethiopian funds.

"Now in the minds of some folks," he concluded, "there may be a question of whether all this efforts is worthwhile.

"Those who have travelled overseas representing consulting (engineering) firms, or contractors working in areas where Point IV or other forms of technical assistance have been active, know that the answer is 'yes' in the form of improved country water resource development, accompanied by general high regard for the United States."

LATIN AMERICAN IRRIGATION DEVELOPMENT JUST STARTING

Irrigation in Latin America's tropical countries is just beginning. What irrigation developments which have been made in the tropical areas have been largely a result of necessity.

These comments were made here today in a report given to a convention session of the American Society of Civil Engineers by L. S. Willardson, agricultural engineer of the U. S. Department of Agriculture, Logan, Utah.

"Until very recently," Mr. Willardson stated, "the technology to control the unusual tropical conditions has not been available. New developments including heavy equipment for land clearing and rapid land preparation, and new herbicides, insecticides, and fungicides should open a new era of food production in tropical countries.

"Engineers are generally aware that present world food surpluses are temporary and localized, and that new land development will be needed. Irrigation is a new frontier which needs increased attention."

Mr. Willardson said that a pioneer in irrigation in the tropics has been the United Fruit Company, of Boston, which irrigates its banana plantations. By irrigation and drainage, the company has effectively reclaimed many thousands of acres of jungle-covered waste land for successful banana production.

"Without irrigation," he noted, "it is doubtful if their operation would be a continuing success."

The wet season in the banana areas usually begins in June and lasts through December, but he said even during these months irrigation is sometimes necessary. Bananas have an 11 to 12 month growing cycle, and require adequate moisture and drainage during all of that period to continuously produce good fruit.

Mr. Willardson discussed irrigation in Honduras, Dominican Republic and Puerto Rico. In Puerto Rico, he said, irrigation has been responsible for an increase of 400 per cent in sugar production since the project was completed in 1914.

Another speaker, J. E. Christiansen, professor of civil and irrigation engineering at Utah State University, Logan, reported to the convention of irrigation and drainage problems in Uruguay.

Nearly all of the irrigation in that country at present is the result of private enterprise, mostly by individuals who pump water directly from perennial streams or lakes and irrigate adjacent lands, Mr. Christiansen said.

Answering his own question of why irrigation is not practiced in Uruguay to a greater extent, he said there are probably many reasons, one of which is the fact that water supply is not readily available to most of the land areas. Also, Uruguay's farmers have had no experience with irrigation.

POPULATION GROWTH BRINGS RARE SANITATION PROBLEMS

The world-wide movement toward "urbanization" and "metropolitanism" offers an unique challenge and responsibility to the civil engineer, it was declared at the convention.

Speaking before the convention, Wesley E. Gilbertson, chief of the Division of Engineering Services, U. S. Public Health Service, said there would be "merit in an annual forum or symposium on urbanization or metropolitanism."

Mr. Gilbertson referred specifically to the need for greater knowledge in water technology, which would cope with new "nonbiological" wastes, "such as detergents."

"The phenomenal growth of population in the last two decades has been matched by the equally fantastic industrial growth, in the course of which new manufacturing processes have been developed, new substances created, and entire new industries born," he declared.

"As a result, new types of wastes are entering the air and streams. Many of these contaminants are of a non-living type, chemically complex and allpervasive in their potential toxicity."

Another example, he said, is radioactive material. "These substances may pass virtually unaltered through our waste treatment systems to the stream and eventually back through our water treatment plants to the consumer's tap.

"Frankly, our existing methods of waste identification, analysis and treatment are not too effective in coping with these new types of contaminants.

"In the parallel problem of atmospheric pollution, new contaminants, complex chemical reactions and synergisms, and potential and actual health hazards require new instrumentation, new methodology and new control measures."

Supporting his recommendation for an annual forum on "Urbanization or metropolitanism," Mr. Gilbertson said that co-sponsors might include the American Society of Civil Engineers, American Water Works Association, Federation of Industrial and Sewage Works Associations, American Municipal Association, federal, state and local agencies, and others.

"Such a forum would provide a needed means of exchange of views on the common problems of technology, economics, planning and inter governmental relations," he said.

"Were the ASCE to make the first step forward, it would give a clear indication that the civil and sanitary engineering groups feel that they have real professional contributions to make.

"As our world becomes more complicated, our task becomes more difficult. At the same time our relationships with other groups grow more important. We must seize every opportunity to improve the intolerable conditions that face our urban populations."

[*Continued from page 12*

the starting period. Should the boiler be operated continuously for a long time, it has to be cleaned after about 4000 working hours.

Feed water for Benson boilers is almost similar to that for drum type boilers, but endeavour should be made that the total salt and oxygen content is as low as possible. Alkalinity for the boilers should not be obtained from the common chemicals used for drum type boilers. Instead ammonia should be added which has the advantage of having less salt content in the feed water. The pH value of feed water may be between 8.5—9% and will be kept constant by adding N_2 H_4 and NH_3. These precautions are necessary to avoid corrosion in the feed line, boiler and the feed pump. Nevertheless, it is obligatory to use corrosion resisting material for feed pumps.

Benson Boiler

In our country, we are having various multi-purpose projects. To meet the peak load or the fluctuations we are installing thermal power stations which also work as base stations during dry season. During partial and overload condition, the drum type boilers will have less efficiency and even at a very low load it might not be possible to run them due to the recirculation difficulties. These difficulties are, however non-existent in Benson boilers. The higher efficiency at all load ranges, less maintenance and less cost and quick response to load fluctuations make it a necessity for power stations. Uptil now, in our country, no such boilers have been installed. For big units such as 75 MW turbosets and above, it is economical to operate them on reheat cycle. Hence it would be worthwhile for the planning engineers of big multipurpose schemes and steam stations to consider installations of Benson boilers.

Technical Notes & News

Aluminium Conductor Plant at Hirakud

In February this year Dr. Hare Krishna Mahtab, Chief Minister of Orissa State inaugurated Alind's second plant at Hirakud for the production of Aluminium conductors. On this occasion Dr. Mahtab paid a tribute to the foresight and pioneering genius of the late Mr.V. Seshasayee. Mr.S. Narayanswami, Chairman of the board of directors, welcomed the guests. Mr. B. V. D. Menon, Managing Director, Managing Agent, and Mr. V. G. G. Nayar, General Manager also spoke. The total capacity of the plants today is 10-15,000 tons of conductors.

Mr. FRANK NICHOLLS' ADDRESS

Mr. Frank Nicholls, President, Nichols Wire and Aluminium Company, Davenport, Iowa, in an informal chat with AL-IND Supervisory Study Group referred to the tremendous technological revolution taking place in the world, particularly the break-through in the usage of aluminium for more and more engineering applications and underlined the significance of the contribution of the Properzi Continuous Casting and Rolling process to world economy.

Mr. Nicholls complimented AL-IND for their leadership and pioneering work in the aluminium conductor business and in the development of the continuous casting and rolling technique. AL-IND runs two Properzi machines in India, the only others who operate more than one machine elsewhere are General Cable Corporation in the U.S.A. and BICC in the U.K. There are at present all over the world nearly 40 units working on aluminium and 10 on zinc.

This is the Aluminium Age. The volumetric increase in world output of aluminium far exceeds that of other metals—even steel. In these inflationary days, aluminium with its stable price is in the best buy category.

The world is fast becoming more and more prosperous. Indeed the whole world looks differently today from 1950. There is tremendous building activity all over the world. In India this is even increasingly so.

This is the Jet Age in communications. The Jet age has already come to India. In the U. S. Railways are becoming more and more obsolete and out of date. It is certainly possible to forecast today large scale transportation of goods even iron ore and other bulk materials at economic rates in Jet Transport Planes. To this extent the St. Lawrence Seaway appears to be uneconomical and superfluous.

The U. S. today is rich and powerful—but the U.S. has its problems too. But there is in the U. S. a tremendous amount of good-will and willingness to help the underdeveloped countries.

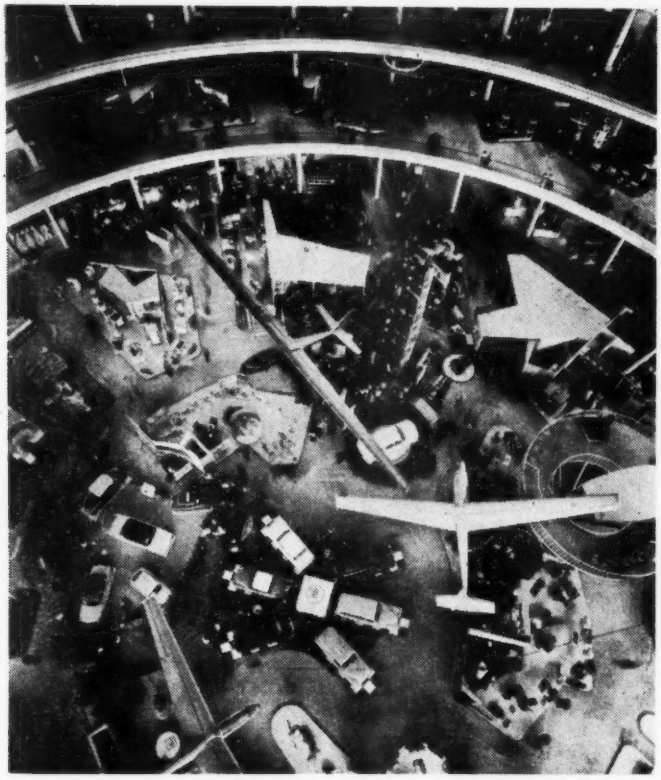
Mr. Nicholls then referred to various technical developments in the continuous casting field. Painting ingots with carbon black before charging into furnaces for example saves nearly 25% of the energy for melting. Mr. Properzi has already perfected and put on the market machines for continuously casting and rolling copper into 1/4" rods. The section of the casting is approximately 2 sq. inches. The casting wheel is 53" diameter The mill has 17 passes. Output is approximately 10 tons per hour.

The aluminium business in the U.S. is today most active and prosperous. Some of the Aluminium smelters are using in some cases electric power produced from low quality coal at the pit mouths. Aluminium in multiplex cables in distribution accounts for 90% of all present-day installations. Messrs. General Cables Corporation have perfected continuous sheathing of cables with aluminium. Battery connections, automobile and aircraft cables are other new electrical applications. Copper cable works like the U. S. Rubber Company and Rome Cable Corporation have been bought over by the aluminium interests like Kaisers and Alcoa. There are thousands of new applications being developed for aluminium wire-fencing-nails. The latest is X-mas tree wire which alone accounted for a sale of over 1.5 million pounds last year by Nicholls Wire.

Mr. Nicholls concluded his address by referring to the major contributions made to the metallurgy by the great pioneer. Mr. Ilario Properzi, the inventor of the Continuous Casting and Rolling process. The Properzi process has enabled smaller companies to gear production of semi finished materials for their own consumption and thus allow semi-integration in production lines with a minimum of capacity.

International Trade Fairs in Czechoslovakia

The changes which have taken place in Czechoslovak foreign trade in comparison with the pre-war period, are characterized by two key developments. In the first place, the territorial structure has altered, since over two thirds of foreign trade volume now go to the Soviet Union and the countries of People's Democracy. On the other hand, however, the total volume is rising steadily and there is a significant increase in trade with the other states as well, primarily those with less developed economies.



The second significant change as against the pre-war period concerns the commodity structure of foreign trade. While before the war, consumer goods were a primary export item, a considerable part of the present foreign trade volume is contributed by machinery and products of the engineering industry. These commodities also constitute a prime feature of the renewed Czechoslovak Trade Fairs. The first Fair was held in September, 1959, in Brno, the second largest city of Czechoslovakia, and was a decisive success from the very first.

The Brno Trade Fair will be held for a second time from September 11 to 25, 1960, and its exhibits will again comprise products of the engineering and metallurgical industries, as well as raw materials and semi-finished products related to these industrial sectors. The exhibits will be shown on an area of 65,000 sq. metres of roofed-in pavilions, and 60,000 sq. metres of open-air space. Improved exhibition facilities against 1959 will include a new ten-storey trade building and an extension of conference space within the exhibition grounds.

Czechoslovak participation in the 1960 Brno Trade Fair includes thirteen foreign trade corporations; among the largest exhibitors are the corporations Strojexport (heavy engineering), Technoexport (complete industrial plants), Kovo (precision engineering), Motokov (vehicles and light engineering products), and Omnipol (aircraft and sports and hunting firearms).

Negotiations are in progress also with foreign exhibitors, the deadline for applications for participation being April 15. It is expected that the 1960 Brno Trade Fair will be attended again by exhibitors from the socialist countries headed by the Soviet Union which last year had the biggest stand among all foreign participants.

Symposium on Foundation Engineering

A symposium on "Foundation Engineering" has been arranged to be held at the Indian Institute of Science, Bangalore in November 1960. The subjects included are :

(*A*) *Exploration and field investigations :*

(1) Subsurface exploration for foundations
(2) Geological aspects of Foundation Engineering
(3) Submarine explorations.

(*B*) *Theory and design :*

(1) Bearing capacity of soils
(2) Settlement Analysis
(3) Comparison between observed and computed settlements
(4) Effect of settlement on super-structure
(5) Stress distribution under foundations
(6) Foundations of highly shrinkable and expansive clays.
(7) Foundations for eccentric loads, horizontal thrust, moving loads, etc.
(8) Methods of analysis for continuous footings.

(*C*) *Pile Foundations :*

(1) Pile formulae and their reliability
(2) Load tests on piles
(3) Study of group action
(4) Bearing capacity and settlement of driven piles and field observations.

(*D*) *Foundations other than pile foundations:*

(1) Foundations of heavy structures
(2) Foundations of long span bridge piers
(3) Design and construction techniques of caisson or well foundations
(4) Foundations of large hydraulic structures
(5) Foundations for special structures like, silos, oil tanks, over head water towers, blast furnaces, nuclear reactors, etc.

(*E*) *Foundation Treatment:*

(1) Problems of drainage, stabilisation, preconsolidation, etc.

(2) Special treatment of soils

(3) Foundation treatment for dams.

(*F*) *Machine Foundations:*

(1) Effect of vibrations on soils

(2) Foundation practice for turbines and turbo-machinery

(3) Foundations for reciprocating machines and forge hammers.

(*G*) *Miscellaneous:*

(1) Mechanical plant and equipment in foundation engineering

(2) Foundations on slopes

(3) Case Reports of foundation failures

(4) Case reports of under-pinning

(5) Foundation Engineering in seismic regions

(6) Design and construction of deep foundations under water.

World's Largest Boiler

Babcock & Wilcox Ltd. announce that they are to supply to the Central Electricity Generating Board a 550,000 kilowatt pulverized-coal-fired Radiant boiler, worth over £5½ million, for Thorpe Marsh power station, near Doncaster, Yorkshire.

The boiler, which will be the largest single furnace boiler in the world, will burn about 200 tons of coal an hour (5,000 tons a day) to produce 3¾ million lb. (1,675 tons) of steam per hour.

By careful design a high degree of compactness has been achieved in a unit that will hve the greatest output ever required from a single boiler; yet, when completed, it will be approximately 170 feet high, equivalent to a modern 16-storey office building. It will have a single, fusion-welded high-pressure steam drum 130 feet long and weighing some 265 tons, which will be lifted into position 160 feet above ground level, in the course of erection.

The boiler will supply steam to the 550 MW turboalternator at a pressure of 2,400 lb. per sq. inch and a temperature of 1,055°F which is equivalent to a dullred heat. To increase overall efficiency, so keeping down the cost of electricity generation some of the steam will be returned to the boiler, for reheating to a high temperature, after partial expansion through the turbine.

The Thorpe March station, with an ultimate capacity of 1,100,000 kilowatts, placing it among the world's largest power stations, will draw its coal supplies fram the Yorkshire and Nottinghamshire coal fields.

EXTENSION OF STEEL WORKS AT BURNPUR

A ceremony was held at the Burnpur Works of the Indian Iron & Steel Company on March 15th when Sir Biren Mookerjee, the Chairman, formally commissioned the finishing stand of the 34″ Reversing Structural Mill. This is the second mill which has gone into operation under the Company's 1955 Extension Programme. In April 1959 two additional stands were commissioned on the Billet Mill and the third mill under this extension programme, namely the new Bar and Rod Mill, is scheduled to go into production sometime this year.

The electrical equipment for all these Mills has been manufactured, supplied and erected by the English Electric Company Limited. This equipment includes the main and auxiliary drives with the latest type of electronic and magnetic amplifier control devices, an Ilgner set, all rectifier equipment and switchgear.

The drive for the finishing stand of the 34″ Structural Mill consists of a 6,650 H.P. 1,360 Volts D.C. Reversing Motor fed from a Ward Leonard Ilgner Set which consists of three variable D.C. generators each continuously rated at 1,740 kW 454 Volts driven by an 11,000 Volt Slipring Induction Motor of 5,000 H.P. rating. The armatures of the motor and generators are connected in series to ensure inherent load sharing between the machines without the necessity of cross compounding control. This method of connection also enables rolling to continue at full torque at a reduced speed of 66.2/3% in the event of failure of one generator.

The two Billet Mill roughing stands are driven by 800 H. P. 600 Volts D. C. Motors fed from a 1,250 kW Rectifier bank. Grid control of the rectifiers provides for inching of the motors and ensures that a constant voltage is maintained at all loads.

The stands of the new Bar and Rod Mill will be driven by seventeen non-reversing D. C. Mill Motors ranging from 150 H.P. to 1,500 H. P. fed from two 2,500 kW 600 Volts banks of grid controlled rectifiers.

Over a number of years, in fact from the days when these Steel Works at Burnpur first started, "English Electric" has supplied the complete electrics for all the Rolling Mills and the total horsepower of motors installed exceeds 100,000.

Mr. Richard Koken, U. S. TCM Heavy Euipment Advisor to the Central Water and Power Commission, New Delhi, making the token presentation of engineering books to Chief Minister Hare krushna Mahtab of Orissa for the use of the Indian Institution of Engineers, Orissa Centre, at the newly-built Hindusthan Steel Technical Auditorium, Rourkela, February 14, 1960. The ceremony marked the Orissa Centre becoming the one-thousandth member of the U.S. Book Exchange Programme, under which the book presentation was made to the Institution.

Editorial

Policy for Atomic Power

We are glad to note that India is taking positive steps towards building Atomic Power Stations in the country. The rate at which the demand for power is increasing in the country due to rapid industrialisation is indeed quite substantial. It is therefore necessary that some long-term view of power generation is taken at the earliest. Hydro and thermal power will continue to occupy important position in the power economy of the country. Even so, in certain regions atomic power may be economic. Apart from this economic consideration, it is evident that nuclear power will in the future become a significant factor in power generation in the world. From this point of view, it is necessary that India, which possesses a substantial amount of atomic minerals, begins to establish atomic power stations earlier than later. It will provide the very necessary experience and training to our engineers and technicians. It will also indicate in what respects we shall continue to depend on foreign help in this regard. Due to favourable political conditions several competing countries are today offering us aid in this respect. This political factor needs to be weighed very carefully before getting involved with any single country. If the huge capital investment required for such stations are not to be immediately borne by India, it may be better if we make a start with two stations with the aid of two countries instead of with only one. An analogy in this regard may be taken from our policy with respect to oil where international competition has been used to our advantage. "Imperialism" in the technical field is a reality today at least in respect of atomic energy. Our undeveloped country will have to take foreign help in this regard. Therefore the recepient country should take full advantage of the competitive climate prevailing among the superior countries in the technical field.

CALCUTTA PORT

During the summer months waters in the Hoogly are reduced to its lowest level. This adversely affects navigability of the Hoogly. It is no new phenomena. It is also well-known that the Calcutta port is a strategic point in the export and import of goods of the country required for its economic and industrial development. Other new ports such as Kandla, Paradeep etc. are still too small to adequately offset the disadvantages of the Calcutta port. While dredging and other river training schemes are being considered, the Hoogly can only be substantially relieved of its difficulties by undertaking the execution of the Ganga Barrage scheme. We have spoken about it on several occasions. The public also has expressed itself strongly. But apart from promises, things appear to go slow. Meanwhile the irrigation schemes, both major and minor, upstream of the Ganges and its tributaries are being sanctioned in quick succession and all these are reducing the quantum of water that would pass through lower reaches of the Ganges to be diverted to the Bhagirathi. The position may soon arise when the Ganga Barrage, even if executed, would cease to perform the functions it was originally intended to serve.

The objections that Pakistan has raised with regard to this project is another factor causing delay. It has been noted by competent technical experts that the volume of water to be diverted by the Barrage would not materially affect the just interests of Pakistan. Therefore the main cause does not appear to be technical difficulty. It is political. Possibly it is linked up with the resolution of the dispute on the canal waters.

To us it appears, however, that such problems would multiply unless the major effort is made to consider the development of these waters, whether of the Ganges or of the Indus or even of the Brahamaputra, on an integral and unified basis irrespective of boundary considerations. This of course implies the resolution of all political disputes with Pakistan and opening up a fresh chapter of trust, mutuality and cooperation between the two countries. We feel that the time has now come when such a major step should be conceived publicly by our government and by that of Pakistan. If the problem of the Hoogly is set in this pattern of relations, it may not be difficult to come to an agreement with Pakistan on the basis of a plan of water resources development in the east by which the port of Calcutta may yet be saved from a disastrous ending. It appears to us that many in high quarters are still wedded to parochial attitudes and are thinking in terms of State interests and not for the country as a whole. If the port suffers drastically, the economy of the whole country will be badly shaken for some considerable number of years.

CANAL WATERS QUESTION

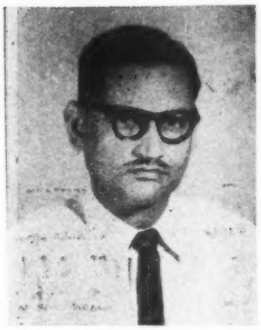
We were hoping that in any of these days the canal water question would be settled, but as we go to the press we are informed that new difficulties have arisen and that this problem is now getting linked up with the Kashmir issue. What exactly are the new problems are not very clear from press reports. But Mr. Iliff of the World Bank does not seem to feel much discouraged by these developments. So far so good. Let us hope that in another couple of months this problem will be resolved and a water treaty ready for the signature of the two governments. We may however take this opportunity of repeating our viewpoint that the best course for such problems would be the unified development of the entire Indus-Basin under joint authority. But this again presuppposes a stable relationship of trust and co-operation. Circumstances around us in Asia are compelling our lazy and distrustful minds in this direction but where is the leadership which has the will to take courage in both hands to cut across historical animosities?

Our Contributors

Mr. J. Klar. Having finished grammar school studies in Budapest, went to Germany and graduated at the Science Faculty of the Halle-Wittenberg University and received a diploma there. Having received university degree he went to serve with the AEG Unio, a German electricity firm, and worked at the Berlin, Koblenz and Breslau branches of that firm. Returning in 1932, he was employed by the greatest Hungarian enterprise for electric energy production; in 1946 was appointed as director of the Technical and Economy Department of that enterprise. He obtained the Reader's Degree on the subject of Energy Economy at the University of Technical Sceinces, Budapest; in 1946, as professor of that University he took the Chair of the Institute of Energy Economy at the Faculty of Economy of the same University. At the present time he is Chief of the Scientific Department of the University, technical Editor of the Periodica Polytechnica and appointed lecturer of the subject of Industrial Economy at the Faculty of Chemical Engineering of the Technical University, Budapest.

Dr. P. Franke, is one of our frequent contributors.

Mr. N. Venkata Row, after completion of the Post-graduate Diploma Course at the Indian Institute of Science, worked as a Research Scholar under Prof. M.S. Thacker. Subsequently for two years he was a trainee in the then Hyderabad State Electricity Department. For the last over seven years, he is with Messrs. Larsen & Toubro Limited—first in their Regional office at Madras later in Bombay and now in the New Delhi office.



Mr. L. N. Misra. Passed combined Electrical and Mechanical Engineering Examinations of the Banaras Hindu University in 1950. Worked as Shift charge Engineer and Maintenance Engineer for 4 years in a Power Station of 15,300 kW till 1954. Underwent training as a Govt. of India Scholar in West Germany till May, 1956. Worked as Steam Power Station Engineer with Messrs. Siemens Engineering & Manufacturing Co. of India Private Ltd. looking after the design and execution of Thermal Power Stations. At present engaged as Erection Engineer at the Hindusthan Steel, Durgapur.

Mr. P. Roy, after passing the M. Sc. Examination in Applied Chemistry in 1946, joined the River Research Institute, West Bengal in 1947 and has been working in the Soil Mechanics section since 1950. At present working as Research Officer, Soil Mechanics, and has been engaged in works on (i) foundation soil exploration in general, (ii) effect of pile driving on the shear strength of soil and (iii) study on seepage in relation to design of embankments.

Statement of Ownership and other Particulars about

INDIAN JOURNAL OF POWER AND RIVER VALLEY DEVELOPMENT

Registration of the Newspapers (Central) Rules, 1956.

FORM IV (Rule 8)

1. Place of Publication	..	6/2, Madan Street, Cacutta-13
2. Periodicity of its publication	..	Monthly
3. Printer's Name	..	P. K. Menon
Nationality		Indian
Address		6/2, Madan Street, Calcutta-13
4. Publisher's Name	..	P. K. Menon
Nationality		Indian
Address		6/2, Madan Street, Calcutta-13
5. Editor's Name	..	K. K. Sinha
Nationality		Indian
Address		211, Park Street, Calcutta-17
6. Name and address of individuals who own the newspaper and partners or shareholders holding more than one per cent of the total capital	..	Books & Journals Private Ltd. *Shareholders:* P. K. Menon, 6/2, Madan Street, Calcutta-13 K. K. Sinha, 211, Park Street, Calcutta-17 H. Ghosal, 22, Bhupen Roy Rd. (Mitra colony) Behala, Cal. B. Bhattacharya, 39, Amherst Row, Calcutta-9

I, P. K. Menon, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Date 1. 3. 60

Sd/- P. K. Menon
Publisher

Engineers' Circle NEWSLETTER

The Engineers' Circle functions with the object of providing a forum for engineering, scientific and allied professions to exchange ideas: to read papers, to organise symposia and lectures, to provide facilities for cultural and recreational activities, and to arrange works visits. It is proposed to publish a News Letter every month as supplement to this journal. This month's News Letter carries summaries of talks given on March 4, 11 and 18, 1960.

ELECTRIC POWER TRANSFORMERS: MODERN TRENDS IN DESIGN

J. K. R. Dastidar

TRANSFORMER, as we all know, is an important electro-magnetic apparatus in the electric power-transmission and distribution systems. It is estimated that the cost of transmission and distribution of power would have been a few thousand times as much as it is today if there were no transformers. This must not insinuate the idea that the price of a transformer is very cheap compared to its construction. Having relatively simple construction, it is probably the dearest electro-magnetic machine. The present day problem therefore facing the designer or manufacturer of transformers is how to reduce the cost of production of transformers. Economy is now probably the order of the day. We have seen the other day Prime Minister Nehru writing a circular letter to the Chief Ministers as to how to cut down the construction costs. The traditional view of economy, namely, reducing the strength of staff is now outmoded. Real economy shall come from modernisation of designs.

Coming now to the field of transformer production, the economy can be achieved by reducing the weights and dimensions of transformers. The transformer consists essentially of two circuits—(1) magnetic circuit and (2) electric circuit—for the purpose of transforming power at one voltage to the power at another voltage following the basic laws of electro-magnetic induction. Associated with these two circuits are : (3) dielectric circuit and (4) thermal circuit. The dielectric circuit is obvious, as, it is required to insulate the windings from earth or one winding from another. The thermal circuit is required to provide a path for the flow of heat produced in the magnetic and electric circuits due to unavoidable transformation losses.

The basic raw materials used for building up a transformer are :

(a) Silicon alloyed steel laminations, usually called "electrical steel".
(b) Electrolytic copper i.e., technically pure copper.
(c) Insulating materials such as paper, press-board, porcelain, etc.
(d) Mild steel plate and stucturals.
(e) Mild steel cooling tubes.

Of the materials, the price of electrical steel and copper constitutes about 50 percent of raw materials. The respective quantities of these two materials depend upon the specific loadings--magnetic and electric, the limitation being, amongst other things, the heating. The deeper knowledge of characteristics of materials and utilisation of the same to the best advantage are probably the chief functions of design engineers. With that end in view, the electrical engineers are now more actively collaborating with metallurgists and physicists in the research laboratories. And this team work has already started showing substantial results. Recently, a completely different method of manufacture of electrical steel has been developed on a commercial scale, largely as a result of research work carried out by metallurgists. This is what is known as "grain oriented cold reduced steel". This steel has got wonderful magnetic properties along the direction of roll and permits of much higher flux, density (say about 15,500 gauses) to be employed without the corresponding increase in the specific core loss per pound. A much lower section of iron will therefore be necessary for a particular KVA rating. This will in turn show saving in copper and copper losses because of the small diameter of the core. The working out at such a high flux density immediately confronts the designer with another problem, namely, the noise level of the transformer. As a result of rapid industrialisation, the transformers are now on longer installed far out in the fields, but are coming nearer to the dwell-

ing. And when we are definitely after better standard of living, we would certainly not like living in the vicinity of a noisy transformer. It is therefore natural that specifications in respect of noise levels of power transformers are now gradually coming through from the various municipal authorities. The problem of noise reduction has consequently engaged the attention of designers of power transformers. Various methods have been successfully tried out in West Germany and other western countries. These include inserting synthetic rubber cushions between the tank and the core clamping structure; also, putting in plastic sound insulating barriers around the radiators in such a manner as not to affect the convection current of cooling air.

The next question is how to cut down the amount of copper needed for windings—that also depends upon the safe current density to be employed, the limitation being the copper temperature, as, above a certain temperature the paper insulation of the windings deteriorates far too rapidly. The losses in the core and coils are transmitted by the oil to the sides of the transformer tank and dissipated into the atmosphere by convection and radiation. Self-cooling results from the natural circulation of the oil and the air caused by the temperature differentials. By taking advantage of these temperature differentials, it is now possible to design much more effective cooling circuit, both inside and outside the transformer. With this arrangement, it has been possible to step up the current density in the copper considerably. On account of the low heat transfer from the oil tank to the ambient, it is generally necessary to greatly increase the tank surface by oil tubes. These oil tubes are flattened or squashed into the various typical sections to increase the surface area and decrease the oil quantity. The limit of output with oil-immersed-naturally-cooled transformers is reached when the tank becomes too large and costly. Another limit is the facility of transportation. Forced ventilation is then adopted, which increases the heat transfer on account of higher air speed, three or four times that of normal air flow. Fans are used to throw the cooling air over the radiator surfaces. With this arrangement, it has been possible to design ON-type transformers upto about 15 MVA capacitty without increasing the bulk unduly. The additional advantage of this forced-air-cooling is that the fans can be automatically brought into action only when the oil temperature reaches a desired limit and this improves the overall efficiency at small loads. With the blowers on, the safe capacity of the self-cooled transformers can be increased by $33\frac{1}{3}$ per cent. This arrangement is much favoured now-a-days in the States.

As it has been observed in the preceding paragraph that above a certain temperature, the paper insulation of the windings deteriorates far too rapidly. The "hottest—spot" temperature for such cellular insulation has been standardised at 105°C. This is the limit which fixes up the specific electric loading of copper. But with the development of glass and silicone insulation, it has been possible to reach a temperature as high as 170°C. A much higher current density can therefore be employed, which will cut down the amount of copper to be used. With the silicone insulation, air-blast dry type transformers are now being built by Russians where the sizes of transformers have been considerably reduced, but at a sacrifice of efficiency of the transformer.

TOWN PLANNING TO-DAY

S. Sircar

TOWN PLANNING to-day does not simply mean laying out some orderly arranged buildings, parks and roads. It does not even mean simply planning the city or the town alone. As a matter of fact every aspect of present day reality has got so much interlinked with each other that it is difficult, if not impossible, to understand and to plan or organise any part of the reality without taking into account its relationship with other parts. And so planning a town or city to-day involves planning the region of its location and this regional plan also is sought to be linked up with the Plan for the country as a whole. That is why Town-Planners to-day like to describe their profession as 'Town and Regional Planning' or 'Town and Country Planning'.

This problem of Town Planning was not so all-embracing in the past. In olden days, civilisation was localised in more or less self-sufficient towns or cities. The Greek City States, the civilisation of Rome, the capital cities of India, Mesopotemia and Egypt were of this nature. In medieaval age, although the number of towns had increased, they retained their self-sufficient characteristics. In those periods, the necessity for planning the town arose out of certain specific requirements or functions, the principal of which was defence. This aspect was expressed most clearly in confining the city within city walls and also in the selection of those sites which were most suitable for defence purposes. But with the advent of the Industrial Revolution, the growth and development of the new civilisation demanded the rapid dissolution of the feudal barriers between the isolated towns ruled by strifing lords. And thus the barriers between the different towns, between the towns and the country-side within a particular nation, and also to some extent between the nations themselves were broken. And in the

course of a century or so mighty industrial nations with giant cities as their focal points came into existence. This extremely rapid transformation and growth occuring in an era with "laissez faire" as the dominant philosophy resulted in a development of the city and the countryside not according to some plan but more or less spontaneously. People in those days believed, unlike us, that if the individual was let alone to develop according to his own choice without any interference or direction from any central authority, the best result would be automatically and spontaneously achieved. And the unprecedented development in the first half of that era seemed to vindicate that belief and blurred their vision to identify or understand the evils arising out of the unplanned and un-coordinated growth. But with the march of time, the evil effects of the new civilisation became too glaring to evade anybody's attention. And the demand for planning and co-ordination arose from every walk of life, including Town-Planning. Thus the modern Town-Planning movement originated in the latter half of the 19th century as a direct reaction to evils of "laissez faire" civilisation. From its very origin, however, modern Town Planning had to contend with a reality which was not only very much complex but also very wide. The necessity and so the function of Town Planning changed considerably. It was not simply the defence requirement of the city that dictated its planning pattern. Town Planning sought to re-organise the totality of the city life and its environs on a more rational basis so that it may serve all the people of the nation. And as it is a planning for the people, so the first prerequisite of Town-Planning is to know the people —how they live, how they work, how they spend their leisure etc. There should therefore be a civic survey to find out all the relevant imformation needed to understand the problem and the needs of the people. This civic survey is to-day considered to be the foundation of modern Town Planning. On this foundation the plan is built which endeavours to slove the problems of the people.

It will be understood now that the modern Town Planner has got to be equipped with some basic knowledge of several subjects which, apparently do not seem to be much related to one another. The civic survey demands a knowledge of Economics, Sociology and Statistics for compiling and analysing the demographic data, and also a knowledge of Geography to understand the physical features and the character of the land. A knowledge of Geology and Civil Engineering is needed for the preparation of the plan in relation to structures, roads, water supply, sanitary engineering etc, of Architecture is required for detailed layout and civic design. A knowledge of Valuation and Survey is needed in the questions of Estate Management and Land Economics. Last but not the least is Law, as legislative measures are essential to implement any plan and also to control undesirable developments.

Thus Town Planning to-day proceeds from an understanding of the totality of the existing reality in all its manifestation and tries to frame a total Plan, for the region or the city or the town as the case may be. This Plan is not a simple sum or conglomeration of different independent improvement schemes, as these schemes can not by their very nature be concerned, either in their conception or in their execution, with the totality of the civic life. Modern Town Planners rather frame an overall Plan first and then formulate schemes, as an integral part of the overall Plan, for a particular purpose or locality which can, of course, be modified within the general framework of the overall Plan.

This brief introduction has been intended to show that Modern Town Planning arising out of a reaction to the sordid state of affairs resulting from "laissez faire" civilisation aims not at patch work here or there but at a total reconstruction of the entire civic design always keeping in forefront the well-being of the people as a whole.

WORK STUDY

A. Khuller

WORK STUDY is essentially a technique of scientific management. Its importance to the industry lies in the immense potential it possesses in pin-pointing and thereby improving other functions of management such as production planning, stock control and maximum utilisation of the three factors of production viz men, materials, machines.

What is work study ? What are its objectives ? The primary aim of work study is to make possible the best utilisation of available resources of men, materials and machines. Unlike the conditions existing in highly industrialised countries in Europe and America, where labour is expensive while machines and materials are readily available, the emphasis in India should be more on materials and equipment rather than on labour.

Work study is divided in two branches viz method study and time study. These two are by no means independent, for no method study is complete without some form of time study and time study without atleast a nominal method study is absurd. In all circumstances, then, for the proper application of work study, these two aspects must be considered jointly.

There is a common belief in this country that work study and financial incentives are more or less

the same thing. This concept is quite erroneous. Work study provides information and data which are then suitably utilised. If part of this information is amplified and further used, financial incentives are possible. In this country, however the utilisation of available resources is far from what it could be, higher productivity by financial incentives possesses the greater scope in the majority of cases as an initial step because of the gross under-utilisation of labour.

The principal technique of method study is commonly referred to as the "Questioning" technique. To each project the approach of why? what ? where? when ? and how ? must be brought. Every single unit of work must be subjected to thorough analysis, first to eleminate the unnecessary, then to simplify, change, improve, standardise and develop a better method, record, install and check it to test for validity. If necessary to re-evaluate the work again. Plant layout, material handling, flow of materials, change in design, all fall within the scope of method study. Method study never does really come to an end. For its best use it must be applied so as to continually improve the methods. There are countless case histories showing the thousands of rupees saved by this technique.

On completion of the method study, when the work is being done under standard conditions with a standard method, the work contact is measured by a time study. In the majority of cases the use of a stop watch is sufficient, but where greater accuracy is required and if work consists of small movements and times below .04 of a minute micromotion techniques e.g., winkcounter motion picture etc., can be used.

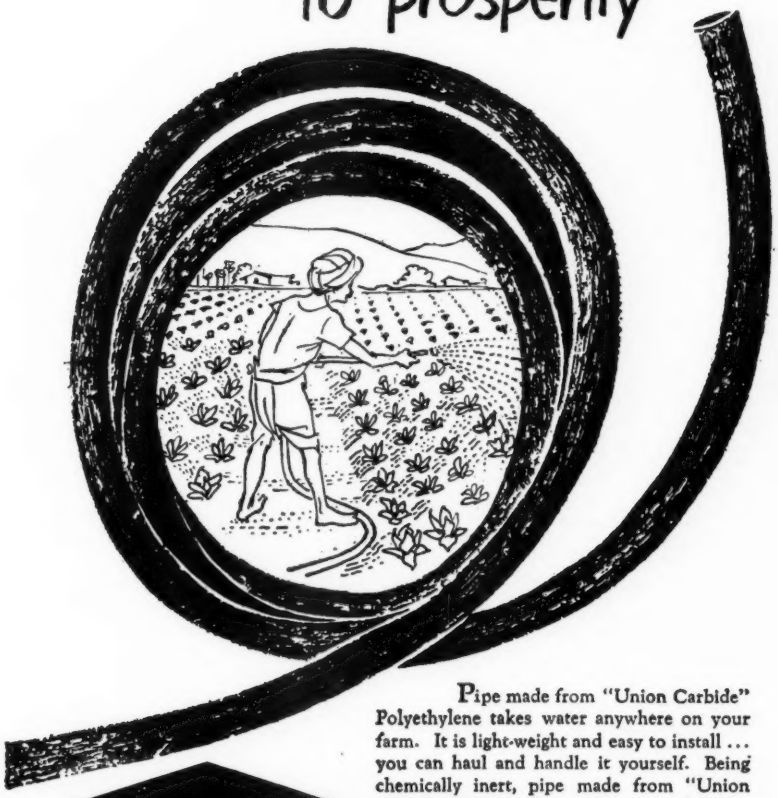
Except in the case of mass production factories where one or two products are being turned out in their thousands, with little or no change in the components and processes between units, the building up and use of element standards is advisable. In jobbing and/or batch production organisations, it is not economical to study each and every job. By studying a representative number or a range, relationships can be derived and used to develop standards for all the jobs in that range.

The most controversial aspect of time study is ofcourse Rating or Assessment. This factor is essential to bring all times to a common base—called the normalised time. This is required to cater for variations in performance between operations, variations at different times of the day and unnecessary variations deliberately brought in by the operator. The rating factor is a mathematical figure representing, in the judgement of work study engineer, the effective pace and effort of the operator in doing a particular job in comparison with the work study engineer's concept of normal for that job. This subjective aspect of rating comes in for a great deal of criticism. Though there are other systems in which the subjectivity has been reduced, they are still unfortunately, in their infancy and lot of research is required, before their validity can be unquestionably established. With experience and constant checks with internationally accepted concepts of normal, the subjective nature of rating is, however, reduced to negligible proportions.

Before commencing the time study with a stop watch, the job is broken down into operations and the operations further subdivided into elements of work. An element should perferably have a precise beginning and a definite ending and lie between .04 to .50 of a minute. This is preferred so as to enable the observer to record the element with the same work content each time, and to concentrate for short periods of time so as to rate accurately.

Having taken and analysed a number of studies, the normal time for the job is obtained. To allow for operator fatigue and personal needs, certain percentages are added to the normal time. There are tables giving these allowances and others (for monotony, arduousness, eyestrain, noise, heat etc.) published by various organisations abroad and by the national productivity council at home, which should be used only as guides. The sum total of normal time and the various appropriate allowances for the job, gives the standard time for that job, *when performed* under standard conditions of working and with standard methods. Many organisations use price work system, that is having evaluated the standard time for a job by some means, the number of pieces per working day, that the worker is required to produce, are calculated. Amongst other disadvantages, this form of information cannot be utilised for interdepartmental and inter-plant comparisons. Surely, as everything that is done must require a length of time, however small or large, while doing it, the common base is *always* time, irrespective of the type, size of products, and time standards instead of piece standards are invariably superior.

pipeline to prosperity



UNION CARBIDE
TRADE MARK

Polyethylene

Pipe made from "Union Carbide" Polyethylene takes water anywhere on your farm. It is light-weight and easy to install ... you can haul and handle it yourself. Being chemically inert, pipe made from "Union Carbide" Polyethylene won't rust, scale or be affected by soil acids.

Write to us and we shall be happy to place you in touch with manufacturers of pipe made from "Union Carbide" Polyethylene.

Union Carbide India Limited will soon manufacture Polyethylene at Trombay Island, Bombay.

INDUSTRIAL PRODUCTS SALES DIVISION

UNION CARBIDE INDIA LIMITED

Formerly NATIONAL CARBON COMPANY (INDIA) LTD.

BOMBAY • CALCUTTA • DELHI • MADRAS

The term UNION CARBIDE is a registered trade mark of Union Carbide Corporation, U.S.A.

NCC 3634

Printed and published by P. K. Menon from Inland Printing Works 60/3 Dharamtala Street, Calcutta 13
Editorial & Managerial Office : 6/2 Madan Street, Calcutta 13

Regd. No. C 3873

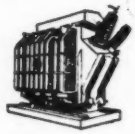
★ ELECTRONIC, ELECTRICAL AND MECHANICAL EQUIPMENT

★ COMPLETE INDUSTRIAL PLANTS

★ COMMUNICATION SYSTEMS

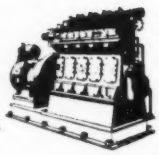
ELECTRONIC:
All kinds of electronic equipment and instruments, including atomic, for industry and research

ELECTRICAL, INDUSTRIAL EQUIPMENT:
A full range of electrical plants and ancillary equipment—transformers, alternators, motors, batteries, rectifiers, switchgear, cables, test and measuring instruments for industry and research



RADIO BROADCASTING AND COMMUNICATION:
Telephone, telegraph and radio equipment as supplied to the All India Radio, Civil Aviation, Posts and Telegraphs Department, Overseas Communications, Police Department, Railways, etc.

MECHANICAL:
Pumps, diesel engines, water treatment plants, turbines, conveyors & mechanical handling equipment, railway rolling stock, etc.



COMPLETE PLANT AND APPARATUS:
for cement, refractory, paper, cardboard, synthetic fibre, fertilizer, and chemical industries

PUBLIC ADDRESS SYSTEMS & LOUDSPEAKERS
"Voice of the Nation"

Distributors:

MOTWANE
PRIVATE LIMITED

Incorporating:
EASTERN ELECTRIC & ENGINEERING COMPANY PRIVATE LIMITED
And
CHICAGO TELEPHONE & RADIO COMPANY PRIVATE LIMITED
Electronic, Electrical & Mechanical Engineers and Contractors
127 Mahatma Gandhi Road, P.B. No. 1312, Bombay-1. Phone 252337 (3 lines). Grams: CHATPHONE all offices
Branches at: New Delhi, Calcutta, Lucknow, Madras, Bangalore and Secunderabad